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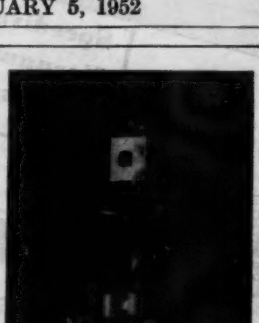

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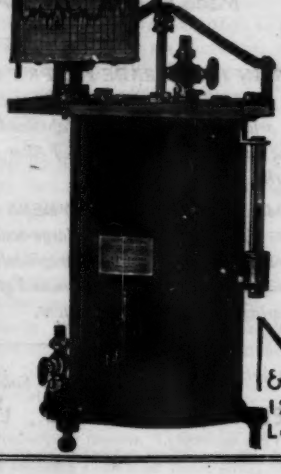

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The annual subscription rate is £6 0 0, payable in advance, Inland or Abroad.
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UNIVERSITIES AND INDUSTRY

THE team of fifteen representatives of British industry and technical colleges and the Ministry of Education which, under the ægis of the Anglo-American Council on Productivity, and with Dr. P. Dunsheath as leader, visited the United States of America to investigate the relations between industry and the universities in that country, was charged with considering particularly the education of the graduate and his subsequent training and employment in industry; it was also to consider such questions as the interchange of staffs and the provision of research facilities. Training for commerce and vocations outside industry was excluded by the terms of reference, and management studies were to be considered only in relation to their place in the general system of scientific and general education.

Management, or rather administrative studies, have been examined by another 'productivity team' sent at the suggestion of the British Institute of Management, in implementation of the recommendation four years ago of the Urwick Committee on Education for Management. The reports of both teams were published almost simultaneously* and are largely complementary. Any overlap is trifling and both reports substantiate the findings of most other 'productivity teams' as to the close connexion between productivity, management and education. They corroborate also the main argument of Sir Ewart Smith's address at the British Association meeting at Birmingham in 1950 on the importance of higher technological education in relation to productivity, concerning the necessity for a continuous increase in the man-power devoted to the application of science, as well as in the quality of that man-power.

The report on Education for Management, indeed, directs special attention to the enormous expansion in recent years in the United States of the provision in universities and elsewhere for training in administrative duties. The object is to prepare suitable men to take their place in management at all levels, and concurrently to give attention to the selection of men suitable for higher management and the provision of appropriate practical experience. Most efficient American firms are convinced of the practical value of these developments, and the 'productivity team' believes that the excellence of American management, noted by all the teams, is to be attributed largely to these factors. Moreover, it believes that American experience has shown that productivity and education for management are closely related. It recommends that British industry as a whole should study means for promoting educational experiments for executive development; individual firms should review their training programmes in the light of American experience, and education authorities should consider how best they can encourage and develop administrative studies.

* Productivity Reports. Universities and Industry. Pp. viii+29+3 plates. 2*s.* 6*d.* Education for Management. Pp. xii+86. 4*s.* (London: Anglo-American Council on Productivity, 1951.)

Similarly, the team studying universities and industry urges leaders of industry in Great Britain, in all grades and sections, to recognize and study the very high place accorded by American industry to the application of science and scientific method in the solution of its problems. In particular, it strongly recommends that British industry should recruit a larger proportion of persons educated in full-time courses, either at the universities or technical colleges, and afford such persons ample scope and encouragement so that full benefit may be gained from their education. Industry should also encourage specialist members of staff to place their knowledge at the disposal of the universities and technical colleges for instructional purposes; provide facilities for initiating and training recruits from universities and technical colleges in specific fields where such provision is not now made; and extend facilities for releasing members of staff for higher education.

These recommendations are slightly more specific than those of the team considering education for management; but both reports avoid making definite recommendations for following American practice. They commend it for study rather than for copying, and suggest that the principles followed in such practice are to be applied only with due regard to British conditions. They call for thought and imagination; and both reports contain comments which should help in formulating wise decisions on a number of current issues, such as the form which the expansion of higher technological education should take; the content of technological studies; the structure and organization of industrial and scientific research; and the bearing of technical education on productivity and the wise use of man-power.

Before discussing the bearing of these two reports on the first of these questions, some differences between the two reports may be noted. That on education for management is admirably factual: the short report is supported by material illustrating its findings, and these findings are clearly set forth. That on the universities and industry is more impressionist. It reviews in successive chapters the American scene in the educational field of the inquiry; engineering and science education in the United States; research in American universities and colleges; and American industry and education. Its findings and conclusions are not precise, and even the terms of reference of the team are not explicitly stated.

The absence of quantitative data, however, does not detract from the value of this report as much as might be supposed. Wisely recognizing that a detailed inquiry was impossible within the limited time at their disposal, the members of the team have exercised great care both in collecting evidence and in generalizing on the information they acquired. Their investigation was generally restricted to an examination of existing relationships between the universities and industry in the United States, and they are concerned in this report to stimulate further thought and inquiry rather than to make superficial and possibly misleading comparisons with British experience.

Even within these limits, this short report contains material to correct misunderstandings in some current discussions, and which should provoke further thought as to policy in Great Britain at a time when even education can scarcely expect to escape the general demand for economy. However lightly, for example, Americans may take the wastage of students, it cannot be a matter of indifference in Britain, where some seventy-five per cent of the university population now receives assistance from public funds. Nor in reconsidering, in the present stringency, the future number of such awards, can we ignore entirely either the fact that in the United States it is rare for more than twenty per cent of the students in an institution to receive such assistance, or the danger to the maintenance of academic standards which might flow from extension of the American practice of seeking paid employment during vacations.

Indeed, the financial problems are essentially similar in both countries and each may well have something to learn from the other, provided full account is taken of the different conditions. Both reports emphasize the general differences which may invalidate a direct statistical comparison—the lower standard of entrance to American universities and colleges, the consequent wider variation in the standard of courses, in which the differences in the quality of the teaching staffs and departmental facilities are also a factor. The British practice of requiring external examiners to take part in all final examinations and in decisions on the award of degrees is, in the view of this team, a powerful element in spreading experience and in maintaining and adjusting standards.

There are points in which British institutions come out well in such comparisons as are attempted; but Dr. Dunsheath's team made a further point which should be noted before considering technological education more particularly. In the United States the term 'engineering' is used to cover all those activities in which the application of science is necessary to the production of the end-product: some of the technological courses in Britain would, in the United States, be modified to include the basic work of an engineering course and the term 'engineering' added to, or substituted for, 'technology'. Thus courses are in chemical engineering rather than chemical technology, and the great and increasing importance attached to chemical engineering as a field of study in the United States is one of the important differences between the two countries.

Both reports direct attention to the Massachusetts Institute of Technology. The Urwick team's report includes a brief sketch of that Institute and a statement of objectives of the Institute which indicate the way in which technology is related to management studies and both to humanistic interests and social needs, and the importance attached to the association of teaching with research. The Dunsheath team points out that, out of the 5,000 students of the Institute (of which 3,000 are residential), about 1,600 are postgraduate, and that the standard of the undergraduate course, while probably higher than in

many American universities, is still about a year behind that of first-degree work in British universities.

The outstanding feature of the Massachusetts Institute of Technology, however, is its postgraduate school, and the standard of work in this school is both high and exacting. Not only are postgraduate courses offered over a very wide technological field in close collaboration with industry, but also the Institute is able to choose its students from the best products of American universities as well as from a large number of overseas graduates seeking admission. The report does not comment on the high calibre of the teaching staff of the Institute; but, apart from the absence of faculties of arts and medicine, regards the facilities for research and the wealth of its material resources as constituting its greatest difference from the universities of Great Britain. Some three million dollars are spent annually on independent research and another twelve millions on sponsored research, and though it is clear from the report of the Institute's Committee on Educational Survey that some concern is felt as to the effect of sponsored research on teaching, the range of research possibilities clearly far exceeds that of any university in Britain.

Leaving on one side the question of sponsored research which, for British institutions and in our present context is irrelevant, the team believes that so far as teaching activities and independent research are concerned the pattern of the Institute is much closer to that of the science and engineering departments of British universities than is generally understood. If that judgment is valid, the argument for establishing an entirely new technological institution of university rank in Britain loses some of its force, as compared with the alternative possibilities of expanding appropriately one or two existing colleges of technology, or extending considerably the technological departments at a few universities. Moreover, as Prof. R. S. Edwards pointed out, in an inaugural lecture at the London School of Economics on October 11, the establishment in Great Britain of such an institute of technology is a matter not merely of bricks and mortar, facilities, or even methods, but still more of a reputation built on men and achievement. Merely to find staff of the calibre required, in sufficient numbers, would be a formidable task; and it would be necessary to build up the reputation which would attract the pick of graduate technologists and the opportunities for important research projects.

These factors did not appear to be weighed sufficiently by Lord Portal in his fresh plea at the anniversary dinner of the Royal Society on November 30 for the foundation of at least one technological university in Britain, with the greatest possible freedom to control its own affairs and with the resources to enable it to attract the best class of teachers from Britain and the Commonwealth. Lord Portal welcomed the expansion of technological departments in the universities as a definite contribution; but urged strongly that only the foundation of a university of technology would really be adequate to meet the immediate need for expanding the capacity in Great Britain for training technologists.

Lord Portal's forthright plea for more attention to technologists will doubtless be duly noted by those who, in consultation with the Minister of Education, are considering Government policy on higher technological education "as a matter of great urgency and importance", as Miss Horsbrugh stated on the previous day in the House of Commons. It is to be hoped that, when the policy is announced, it will prove more enterprising and imaginative than that of the last Government. Lord Portal's speech can have left no one in doubt as to the priority which technological education should receive; he placed it in front of everything but rearmament, and to that also it could contribute.

Whatever the means adopted for securing the expansion of higher technological education in Britain, a considerable expenditure will be required; nor will the country's immediate or long-term needs be met if there is undue regard to particular interests. Patchwork and the excessive concern to avoid offending or disappointing particular authorities or interests which have marked the White Paper on Higher Technological Education will be fatal.

In any event, the immediate limit on expansion proposals is likely to be set neither by finance nor materials, but by the practical difficulties in assembling the staff required. At this point the expansion of higher technological education is linked up with that of the universities in general, and also of technical education—and that in respect not merely of the scale of expansion but also of the content of technological education.

On the question of numbers, the report of the 'productivity team' on universities and industry gives no guidance. The team took the view that the large number of engineering graduates employed in American industry undoubtedly contributes to increased productivity and to bridging the gap between scientific research and production. It is convinced that British industrialists require more qualified engineers than they can recruit at the present time; but it gives no guidance as to how many are required, and is content to urge a close study of how and where such men should be educated. It also recommends, besides this expansion at the highest level, immediate attention to the provision as rapidly as possible of extended facilities for preparing a large number of young men for industry, giving them a broad general education on a full-time basis, with a technical standard at least as high as that of the present Higher National Certificate courses.

This is the sphere in which expansion of the technical colleges in general is required; though it will be noted that the team in this report does not assume that such expansion is the only way in which such technicians are to be provided, and suggests that the problem of how and where such men should be educated requires close study. What is clear above all else from both these reports is the extent to which problems of university expansion, higher technological education and technical education are interlocked, and are related in turn to the general organization of the nation for scientific and industrial research through the close relation which exists

between research and teaching at the higher levels. To the solution of these problems the universities, the technical colleges and industry itself, as well as the Government, have much to contribute. Although the lead must come from the Government, both in the formulation of policy and the provision of the appropriate means—whether under the Lord President of the Council, or through the Advisory Council on Scientific Policy or the University Grants Committee—for seeing that expansion is kept in step, this report of the team under Dr. Dunsheath may well stimulate the closer association which is essential to the smooth implementation of policy.

EDWARD JENNER, NATURALIST

A Bio-Bibliography of Edward Jenner, 1749–1823

By W. R. LeFanu. Pp. xx+176+29 plates. (London: Harvey and Blythe, Ltd., 1951.) 84*s*.

THE main concern of this volume is a bibliographical history of Jenner's medical discoveries. This has involved a voluminous correspondence and many tedious researches into bibliographical rarities and side-issues. All the relevant and available material has been faithfully and meticulously sifted by Mr. W. R. LeFanu, and he must be complimented on having in all human probability exhausted his subject. His work is, in fact, the first complete survey of all the editions and translations of the cow-pox inquiry of 1798 and also of the long series of Jenner's later explanatory memoirs, observations, instructions, propaganda and letters on vaccination. Richardson's belated and rather strange criticism of Jenner published in *The Asclepiad* of 1889 does not apparently come within the scope of the present work, which is unfortunate, as the author's opinion of it would have been illuminating.

But interesting and important as are the medical issues, many readers of the present review will turn preferably to Jenner's observations in the field of Nature. Here he owes acknowledgments to the stimulus and guidance of his mentor, John Hunter; but Jenner was himself so engrossed and ingenious a student of country life that he may well be regarded in his modest way as the Gilbert White of medicine. His merits as a naturalist have unfortunately been obscured by his discovery of vaccination.

Jenner's important observations on the cuckoo and the migration of birds have not been generally recognized. They are not mentioned by Eagle Clarke (1912), Mullens and Swan (1917) and Thomson (1926), and his memoirs are not represented in the catalogue of the great ornithological library of E. Ayer (1926). Indeed, Waterton (1838), Seebohm (1884) and Raspail (1925) flatly rejected Jenner's discoveries on the cuckoo, the last-mentioned author even dismissing them as an "absurd legend". On the other hand, ample confirmation came from Montagu (1802), Blackwall (1824), Macgillivray (1840), Newton (1893) and Jourdain (1925). Jenner, in fact, from his own observations of 1787, was the first to give a detailed and accurate account of the "murderous eviction" by the newly hatched cuckoo of the eggs and fledglings of the foster parents, and hence to become the sole object of their nurture and care. The statement, sometimes made, that this astonishing discovery is to be found in Aristotle is based on a misreading of the text. Jenner also found that young cuckoos are structurally modified to enable them to achieve this act of piracy. He was, however, disposed to minimize differences in size and markings between the eggs of the fosterer hedge-sparrow and cuckoo, whereas normally they are easily distinguishable in those respects, and also in the last resort, as he himself had found, by weight. This is not to gainsay the fact that the size of the cuckoo's egg has some relation to that of the fosterer, as Latter maintained in 1901, thus confirming Jenner. In the first draft of the cuckoo memoir Jenner had concluded that the eggs and nestlings of the fosterer were ejected by that bird herself; but in 1787 he had discovered his error, and therefore the correct version appears in the published paper of 1788.

Jenner's views on the migration of birds were published posthumously in 1824. He was convinced of the reality of migration and of the stamina and urge necessary to undertake and complete it. The possibility of hibernation was scouted, and he carried out marking experiments which showed that birds returned to the same spot year after year. He believed that the cause of the migratory movements was the periodic efflorescence and subsequent shrinkage of the genital glands, in which view he may be deemed the precursor of the modern researches of Rowan.

In addition to his observations on the cuckoo and the migration of birds, Jenner carried out numerous investigations on hibernation and digestion in the hedgehog. It was in connexion with this work that Hunter addressed to Jenner his famous letter dated September 25, 1778, which Mr. LeFanu mentions but does not reproduce in full. Jenner also directed Hunter's attention to the difficult problem of the freemartin, and supplied the material on which Hunter based his memoir of 1767 on the bottle-nosed dolphin. The species was undoubtedly *Tursiops tursio*, and not the common dolphin *Delphinus delphis* as Hunter supposed.

The work has been handsomely printed and bound: but most of the illustrations would have been better reproduced as line blocks. The author is to be congratulated on the completion of this truly admirable bio-bibliography. F. J. Cole

THE SYNTHETIC APPROACH TO EVOLUTION

Variation and Evolution in Plants

By G. Ledyard Stebbins, Jr. Pp. xx+643. (London: Oxford University Press, 1950.) 50*s*. net.

FOR many years, the fountainhead of evolutionary thinking for botanists has been in California. Outstandingly prolific and versatile among the workers there has been Prof. G. L. Stebbins, and it is fitting that it is he who has produced this volume, in which he fully acknowledges the advice of many contemporaries. Only a sound and comprehensive book could be expected in such circumstances, and there can be no doubt that this is a work which will be used with gratitude by specialists as well as biologists in general for many years. The author's style is so lucid that this large book may be read through from cover to cover in relatively few sessions. Would that some other famous authors could keep simple facts so free from mystery!

The theme of the book is 'Neo-Darwinian'—"evolution has progressed chiefly by the accumulation of

small changes, each with a relatively slight effect rather than by single large jumps" (p. x)—and Prof. Stebbins is an ardent disciple of Dobzhansky and G. G. Simpson. The first four chapters are devoted to variation in its relation to taxonomy, genetics and natural selection. Genetic systems are considered as factors in evolution in a separate chapter, while others are devoted to methods of isolation and to the effects of hybridization. As this is a botanical text, polyploidy merits a couple of chapters and apomixis and structural hybridity have one each. Evolutionary trends are considered both in the karyotype and in external morphology, and the last chapter is devoted to a consideration of the various rates of evolution (as revealed by fossils and by contemporary plants) and to the problems presented by modern distributional patterns. That this is good measure must be agreed.

The first four chapters call for little comment here except that of recommendation. The detailed presentation of what film scenario writers would call "The *Camelina* Story" summarizes the scattered literature of a fascinating story of adaptation in relation to demonstrable selective forces and is made to show the importance of selective correlation and adaptive compensation. Another important point is Prof. Stebbins's insistence that periods of reduction in numbers of individuals are very important in the origin of hybrid inviability and sterility. His case is convincing.

The chapters on apomixis and polyploidy are particularly striking; they are aspects of plant biology, for the study of which the author is justly famous. Surprisingly, however, it is here that some criticisms may be made. It is unfortunate *Selaginella* should be quoted (p. 300) as a genus of Lycopsida in which polyploidy is found, for it is just here that it appears to be absent. On the other hand, the Moraceæ, quoted as being nearly or entirely devoid of polyploidy, depend for this title on the large genus *Ficus*, polyploidy being quite common elsewhere, while *Morus nigra* has the distinction of possessing one of the highest chromosome-numbers ever discovered ($2n = 308$). Similarly, despite the excellent treatment of apomixis in relation to variation, it could be that Prof. Stebbins is a little over-definite about the lack of an evolutionary future for facultative apomicts and structural heterozygotes. Some confusion is caused by the indiscriminate use of the names *Onagra* and *Eu-œnothera* to represent the same subgenus and, elsewhere in the book, *Orphrys* appears for *Ophrys* consistently. These, however, are trifling points to set against the sustained excellence of the chapters in other ways, and they are included only after a desperate effort on the reviewer's part to find something about which to be critical.

Perhaps the first half of the chapter on "Genetic Systems as Factors in Evolution" is the least satisfying in the book; so much here is of great value, yet there is a misleading heading which tells us that a section is concerned with "Mutation and Evolution in Asexual Organisms", although, unfortunately, it does not deal with this important subject. The section on "Haploidy and the Evolution of Diploidy" contains a stimulative hypothesis; but its basis in fact is disputable, as it rests on comparisons made where there are no standards of reference, and upon simplifications which might surprise cryptogamic botanists. The author's sureness of touch tends to desert him when he deals with plants other than the Spermaphyta.

No one has been more successful at applying Simpson's ideas of differential evolutionary rates to plants than Prof. Stebbins, and there is no doubt that the last chapter, in which these ideas are applied fully, is one of extreme importance. Also, one of Prof. Stebbins's major contributions to the interpretation of evolutionary methods has been his theory of the relatively sudden origin of species on the diploid level after interspecific hybridization (p. 289). Evidence supporting this theory is being accumulated, particulary in the western United States. It may be expected to apply to European groups, and the genus *Orchis* comes to mind at once in this connexion.

More than 1,250 references are cited, and this, alone, gives evidence of the tremendous energy put into the preparation of this comprehensive volume. That the critical discussion of such a huge quantity of literature has not been too much for a single author is amazing, although it raises in the reviewer's mind a doubt as to the general suitability of such a task for one man. An otherwise excellent recent symposium on evolution suffers from the lack of a central theme and, as a result, consists of a series of authoritative fragments. Nevertheless, if a slightly less diverse group of specialists could be brought together to write the chapters of an evolutionary text, subject all the while to the guidance of a capable editor and to critical evaluation of each chapter by the remaining contributors, such a wide field might be covered without loss of unity. No lesser man than Prof. Stebbins could have done this job as well. Perhaps, as the literature grows still further, no later man will be able to do it at all.

H. G. Baker

SCIENCE FOR THE LAYMAN

The Neglect of Science

Essays addressed to Laymen. By F. E. Simon. Pp. vi+138. (Oxford: Basil Blackwell, 1951.) 8*s*. 3*d*. net.

In this book, Prof. F. E. Simon has collected a series of essays published in the *Financial Times* during the past three years, some under the title of this book, others on fundamental research, America revisited, the waste of coal, economical heat production, the prospects of atomic power, power sources of the future, a national fuel policy, isotopes in industry, and oxygen in industry. There is also a co-operative essay with Dr. D. K. C. MacDonald, an unpublished essay of June 1949 on feeding the world's population, and a concluding essay "Some Reflections on Accuracy". Addressed to the layman, they are well written, and expound clearly and cogently the need and the opportunity for the fuller use of science in the utilization of some of our resources. On some topics, such as the use of coal and heat conservation, Prof. Simon is frankly controversial; and if dentures and spectacles have hopelessly prejudiced his argument for government action in Great Britain in the installation of the closed stove, his persuasiveness may induce private initiative to deal with a problem that the coal situation renders increasingly acute.

To the man of science, some of Prof. Simon's essays will appeal as models of clear exposition of complicated subjects to a non-technical reader; for example, those on the use of isotopes in industry and on 'electronic brains'. They are examples of just what is required if there is to be a widespread public appreciation of the true limitations of science as well as of

the extent to which it could be utilized to further productivity and our general economic and industrial welfare. It is to be hoped that they will inspire other scientific workers to share in that task of education, the importance of which was rightly stressed in the recent presidential address at Edinburgh to the British Association for the Advancement of Science.

For the rest, Prof. Simon makes many sound points in regard to the expansion both of technical and of technological education, the necessity for including men of science on administrative bodies, both in industry and elsewhere, if sound policies in such matters as, for example, fuel, the financing of scientific research and the conditions most stimulating to such work are to be formulated. They are not new, but their relevance to the present situation is made clear, and Prof. Simon insists that the most important measure required to improve industrial efficiency in Great Britain is reform of the system of technological education. He himself favours the creation of at least one, and preferably two, really first-class institutes of technology with the full support of industry, and insists that merely to patch over obvious shortcomings would be fatal. R. B.

THRESHOLD SIGNALS IN COMMUNICATION ENGINEERING

Threshold Signals

Edited by James L. Lawson and Prof. George E. Uhlenbeck. (Massachusetts Institute of Technology: Radiation Laboratory Series, No. 24.) Pp. xii+388. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 42*s*. 6*d*.

THIS book is a worthy companion to the earlier volumes of the Radiation Laboratory Series of the Massachusetts Institute of Technology already reviewed in *Nature*, and it gives a thorough and exceedingly clear exposition of the problems associated with the detection of weak radio signals in the presence of noise and interference of various forms. An incoming signal may be of several types, for example, amplitude-modulated continuous wave, frequency-modulated continuous wave, and pulsed; the various kinds of receiver are accordingly discussed in conjunction with the types of signal which they are designed to receive.

Human perception of certain signal properties depends not only on what is presented to the observer by the indicator, be it a meter, a loudspeaker or a cathode ray tube, but also on what use he makes of this information. The human observer must therefore be considered as a part of the receiving system, and it is even sometimes convenient to express human limitations in terms of certain indicator or receiver parameters; for example, the human memory time can be related to an equivalent time constant or bandwidth in the receiver.

After a brief introduction there follow chapters on types of signal and methods for their reception; and a theoretical treatment of the characteristics of noise, together with some properties of probability distributions used in the general analysis. Chapter 4 discusses the basic origins of internal noise associated with fluctuation phenomena in resistances and thermionic vacuum tubes; there is also brief mention of current noise, flicker effect and positive ion fluctuation. Receiver noise is treated in Chapter 5 and external noise sources in Chapter 6. The next six chapters deal with the detection of pulsed signals in the presence of the various kinds of noise, and with the several kinds of indicating instruments which can be used. The final chapter, 13, is devoted to a study of threshold modulation for amplitude-modulated and frequency-modulated continuous-wave systems.

Although, as the authors point out in the preface, the book is mainly limited to a description of the work done at the Radiation Laboratory during the Second World War, the treatment is nevertheless broadly based, and it should be of great help to those working on problems in this important field.

J. A. Saxton

DETERMINATION OF SILICATES IN MINERALS

Silicate Analysis

A Manual for Geologists and Chemists, with Chapters on Check Calculations and Geochemical Data. By Dr. A. W. Groves. Second edition. Pp. xxiii+336. (London: George Allen and Unwin, Ltd., 1951.) 25*s*. net.

IN a second edition, one looks for improvements and additions. The revision of this book has been well done; classical methods of silicate analysis rightly continue to provide the backbone of the subject-matter.

A book containing so much detailed descriptive matter inevitably provides many opportunities for constructive comments. A number of examples may be given. The description of weighing by the 'method of swings' should surely have been followed by notes on the aperiodic balance, which, even for semi-micro work, is now rapidly replacing the more orthodox type. The hydrogen sulphide reduction for the total iron determination is now less frequently used than formerly, as the method has been shown by Lundell and Knowles to be imperfect; by the hydrogen peroxide method, an accuracy of $\pm$ 0·01 per cent, for a rock containing one per cent or more of titanium, can only be attained by using a photoelectric absorptiometer, which incidentally allows of an accurate determination in the presence of much iron; the use of dichromate (with a redox indicator) in place of permanganate, for the ferrous iron determination, provides a more permanent end-point. The peroxidized titanium method for fluorine may be completed by coloro-volumetric comparison with a standard fluoride solution and, as a precautionary measure, the zinc nitrate precipitation should be followed by an ammoniacal zinc oxide precipitation, because incomplete removal of aluminium may cause serious errors. The dangers attending the use of hot concentrated perchloric acid should be emphasized.

The chapters dealing with geochemical data and mineralogical calculations provide excellent summaries; but I object to the heading "Computations as a Check on the Accuracy of Chemical Analyses". A chemical analysis is, or should be, more correct than deductions based on norms or micrometric measurements; in calculating a mineral formula, the analysis of a pure mineral provides the facts, which should be used to check or modify the theory, not *vice versa*.

The book should be in the hands of all who are interested in the chemistry of rocks and minerals.

C. O. Harvey

Calcul opérationnel

Par Édouard Labin. (Abrégé théorique et pratique de mathématiques supérieures.) Pp. iv+150. (Paris: Masson et Cie., 1949.) 780 francs.

THE Laplace transform has a large literature, ranging from severely abstract studies of the theory to manuals of rules and recipes for the manipulator, as far as these are required for the solution of technological problems. For adding to this collection, M. Édouard Labin gives the reason that his precise objective is not attained by any of the existing books. His treatment is not to be one in which the mathematician can find flaws, nor is it to be centred on physical problems. He wishes to give a brief, accurate and comprehensive account of the topic in a form suitable for those who wish to acquire it for use, whether in other branches of mathematics, or in other fields of science, assuming these readers to have a sound knowledge of integral calculus and analysis.

To this end, M. Labin rejects the closely woven deductive style of the "Cours d'Analyse", and instead, for example, he frames the enunciations of theorems as answers to the sort of question the user is likely to ask rather than as stages in an abstract mathematical formulation; he is content with explanations instead of demonstrations, leaving the reader to supply details or look them up elsewhere. In order that this scheme should not reduce to merely another collection of recipes, he uses the resources of ideographs, diagrams, tabulated matter and the emphasis of lavish italic and Clarendon type. There are nine sections on the theory of the method. The remaining four show, without examples, how it can be applied to ordinary and partial differential equations, integral equations and difference equations.

The student would probably be well advised to acquire a general acquaintance with the main ideas of the Laplace technique from one of the many semi-popular accounts before turning to this book to fill in the gaps.

Elementary Principles of Statistics

By A. C. Rosander. Pp. x+693. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1951.) 45*s*. net.

MR. ROSANDER states an intention of giving a non-mathematical introduction to the science of statistics. Unfortunately he shows no evidence of having one of the two motives that would justify this intention: to say something new, or to present standard material in a new way. Without originality or inspiration, his thirty-six chapters pursue the long and long-familiar trail, from elementary ideas and descriptive properties of frequency distributions to sampling theory, analytical techniques and significance tests for scientific data, and methods of inductive inference.

The presentation of general statistical principles, in the early part of the book, is sound, though it contains little that has not been said as well before. To the reader of very restricted mathematical knowledge, the argument will often seem too mathematical, yet the dogmatic assertions of formulæ for various distributions and estimations will be completely unsatisfying to a mathematician. The author would have better fulfilled his purpose had he explained the meaning and logical structure of the methods rather than rested content with displaying algebraic formulæ. Instead, though actually erroneous statements seem few, the misleading impressions sometimes created suggest that he is imperfectly acquainted with many of the procedures he describes in the later chapters. Many examples, of which the best have been taken from other publications, are fully worked, but with little critical explanation of the reasons for choosing certain methods and the limitations on their use. For his own contribution to illustrative examples, Mr. Rosander has relied far too much on fictitious data, though he has presented some interesting experimental and observational material (especially as exercises for the reader). D. J. FINNEY

The Identification of Molecular Spectra

By Prof. R. W. B. Pearse and Dr. A. G. Gaydon. Second edition, revised. Pp. xi+276+12 plates. (London: Chapman and Hall, Ltd., 1950.) 50*s*. net.

THIS book is so well known that its scope and contents require no discussion. The value of such a compilation does, however, tend rapidly to depreciate unless, periodically, a new edition is prepared incorporating the more recent advances in the particular field. During the ten years since this book first appeared, many valuable additional data have been obtained, and the second edition therefore makes a most welcome and timely appearance. To incorporate all these new data without substantially increasing the size and cost of the book, to assess the relative values of old and new data, and to enhance the quality of presentation by small—but important—modifications here and there, were tasks demanding a rare skill, a complete familiarity with current work, and meticulous care and patience. The authors have displayed all these qualities and qualifications, and they are to be congratulated on bringing the valuable information of this well-established reference book up to date (references to publications early in 1950 are included) in such an acceptable manner and with such a surprisingly, but pleasantly, small increase in price of only eight shillings.

Horned Beetles

A Study of the Fantastic in Nature. By the late Gilbert J. Arrow. Edited by W. D. Hincks. Pp. vii+154+15 plates. (The Hague: Dr. W. Junk, 1951.) 8.80 guilders.

G. J. ARROW, who died in 1948, had been on the staff of the British Museum (Natural History) for more than fifty years, studying Coleoptera, particularly the Lamellicornia. This book, which was virtually completed at the time of his death, deals with a subject by which he had long been fascinated—the significance and origin of the fantastic horns that are so common in these and other beetles. It is a book in the Darwinian tradition: a closely woven argument supported by a wealth of illustrations from field observation and museum study.

These bizarre structures, whether gigantic mandibles or adventitious outgrowths of the head, thorax or limbs, present remarkable parallels with the horns and tusks of mammals. They are almost confined to the male, show great diversity of form and are rarely, if ever, employed as tools. Arrow rejects Darwin's theory of sexual selection and explains their existence on the basis of two classes of phenomena: the males do little useful work and so these useless or obstructive outgrowths are not curbed by natural selection; the excrescences are a product of increased bulk, since in a species or in a group they enlarge at a greater rate than the body as a whole. This thesis, when it is expressed in the terms of biometry, physiology and genetics, is one that will obtain wide support at the present time. V. B. W.

SCIENTIFIC CENTENARIES IN 1952

By Eng.-Captain EDGAR C. SMITH, O.B.E., R.N.

IT is probable that no centenary commemorations in 1952 will excite wider interest than those being arranged in connexion with the five-hundredth anniversary of the birth of Leonardo da Vinci, painter, sculptor, architect, engineer and inventor, and recognized as one of the greatest of them all. Born on April 15, 1452 (O.S.), at Vinci, between Pisa and Florence, he was the natural son of Piero da Vinci, a Florentine notary, and Catherine, a peasant girl. Both his parents married in their respective stations; but Leonardo was treated by his father as his legitimate son. His remarkable talents being recognized, he was apprenticed to the Florentine goldsmith and painter Andrea del Verrochio (1435–88). When about twenty-eight he visited the East and on returning to Italy in 1482 settled at Milan, where he was patronised by Ludovica Sforza, the Duke; but after the fall of his patron in 1500, Leonardo entered the service of Cesare Borgia, then Duke of Romagna, as artist, architect and engineer. His fortunes were, however, much affected by the incursion of the French into northern Italy, and in 1508 he was employed by Louis XII. Eight years later, Francis I of France gave him the Château of Cloux, near Amboise, as his place of residence, and there he died on May 2, 1519, and was buried. He was then sixty-seven and unmarried. "No character in history," said one writer, "corresponds more closely to our idea of the man of genius than Leonardo da Vinci."

Born a few years after the invention of printing and a year before the capture of Constantinople by the Turks, Leonardo counted among his older contemporaries Cabot, Columbus and Regiomontanus, and among his younger contemporaries Michelangelo, Raphael, Copernicus, Erasmus and Luther. He was essentially a forerunner, and it was a misfortune for the world that his manuscripts, full as they are of observations, calculations, ingenious devices and speculations, should have been scattered and lost sight of for two and a half centuries. Since their discovery, however, a vast literature relating to Leonardo has sprung up, from which it is seen that his work has as much interest for the man of science as the artist. In a lecture at the Royal Institution, published in *Nature* of May 6 and 13, 1920, Mr. Edward McCurdy said that "Leonardo's researches in natural and applied science cover so wide a field, and specialization in these days has so divided knowledge into water-tight compartments, that properly to gauge the value of his contributions to scientific research would require a combination of many trained intelligences".

Leonardo counted among his intimate friends the mathematician Luca Pacioli, the author of the earliest printed work on arithmetic and algebra, and it was their collaboration which led to the establishment of an academy of arts in which the study of geometry was cultivated. Other academies sprang up in Italy in the sixteenth century, but it was not until the first half of the following century that the gatherings of scientifically inclined men took place in England which led to the foundation of the Royal Society in 1660. The gatherings in London were closely connected with the activities of the professors of Gresham College, housed from 1596 in the old mansion in the City of the Elizabethan magnate Sir Thomas Gresham. There were seven chairs in all, including those of geometry and astronomy, the holders of which included Peter Turner, Dr. John Greaves and Samuel Foster, who all died in 1652. Turner, the son of a physician who attended Raleigh in the Tower of London, and Greaves, the son of a Hampshire rector, were both Fellows of Merton College, Oxford; and, while Turner in 1620 and 1630 respectively succeeded Briggs as Gresham professor of geometry and Savilian professor of geometry, Greaves was Turner's successor in London in 1630 and the successor of Dr. John Bainbridge as Savilian professor of astronomy in 1643. Both were royalists, and in 1648 this led to their being deprived of their chairs, after which they retired to London, where both died and were buried. Their contemporary, Samuel Foster, a native of Northamptonshire, was educated at Emmanuel College, Cambridge, his connexion with which probably led to his friendship with Jeremiah Horrocks. Removing to London, he held the Gresham chair of astronomy for a few months in 1636, and again from 1641 until his death in the College in May 1652. He was one of the first promoters of experimental science in England, and joined with Wallis, Wilkins and others in the meetings, at which "Our business was," as wrote Wallis, ". . . to discourse and consider of Philosophical Enquiries, and such as related thereunto: as Physick, Anatomy, Geometry, Astronomy, Navigation, Statick, Magnetick, Chymick, Mechanick and natural Experiments".

Other scientific tercentenaries which occur this year are those of the births of the French mathematicians, Michel Rolle (1652–1719) and Paul l'Hoste (1652–1700), and the German chemist, Wilhelm Homberg (1652–1715). Rolle was long a teacher in Paris, where he was given a pension by Colbert, and a seat in the Royal Academy of Sciences, while l'Hoste, a Jesuit, held a chair of mathematics at the Naval School at Toulon and published a work on naval construction. Homberg's birthplace was Batavia, Java, where his father was a commandant. The family returning home, young Homberg studied law at Leipzig and became an advocate at Magdeburg. But science proved a stronger attraction, and after travelling and studying here and there, in 1691 he settled in Paris, became physician to the Duke of Orleans, married the daughter of the botanist Dodart, and was made director of the laboratory at the Academy of Sciences; he was regarded as one of the most learned chemists of his age.

Passing from the tercentenaries to the bicentenaries, no apology is needed for including that interesting character, Dr. William Whiston, who was born on December 9, 1667, and died at the age of eighty-four on August 22, 1752. The son of a Leicestershire parson, and himself at one time vicar

of Lowestoft, his mathematical attainments led Newton to choose him for his deputy and successor as Lucasian professor of mathematics, to which post he was appointed in 1703. But like Newton, Boyle, Priestley and others, Whiston studied and wrote on theology, and his unorthodox views led to his being deprived of his chair in 1710, and from that time he lived mainly by lecturing and writing. His death took place at Lyndon, Rutland, where his tomb can be seen. Known to three generations of men of science, the friend of Cotes, Hauksbee, Halley, Flamsteed and Woodward, as well as to men such as Addison and Steele, Whiston in his memoirs describes how his lectures and writings on the solar eclipse of 1715 brought him presents from noblemen—"twenty guineas from the Duke of Newcastle"—by which he gained altogether £120, "which in the circumstances I then was, and have been since, destitute of all preferment was a very seasonable and plentiful supply, and as I reckoned maintained me and my family for a whole year afterwards". Given much to keeping fasts, on one occasion when he refused a glass of wine, Halley told him, "He was afraid I had a pope in my belly".

The tale of 1752 includes the names of men famous in their own time, and of men famous for all time. In the month of February 1752 was born the Italian natural philosopher, Giovanni Fabroni (d. 1822), contemporary of Galvani and Volta, a writer on the voltaic pile and, under Napoleon, a holder of public offices. The month of June saw the birth of the French astronomer, Joseph Beauchamp, who accompanied the ill-fated expedition of Napoleon to Egypt and who died in 1801 soon after his release from captivity by the British. July not only saw the birth of another Italian man of science, Barnaba Oriani (d. 1832), at one time director of the Brera Observatory at Milan, and of the Swiss natural philosopher, Marc Auguste Pictet (d. 1825), who succeeded to the chair held by de Saussure at Geneva, but also the birth of Joseph-Marie Jacquard (d. 1834), one of France's greatest mechanical inventors, who combined the devices of others with his own to give the world the 'Jacquard' loom for the weaving of figured goods. The events of the French Revolution and the reign of Napoleon both affected the fortunes of Jacquard; but his latter days were passed pleasantly enough. His birthplace was Lyons, and it was the Lyons municipality which set up his statue. Lastly, the month of September 1752 saw the birth at Toulouse of the eminent French mathematician Adrien-Marie Legendre, whose name is frequently associated with those of Lagrange and Laplace. Legendre seems to have been singularly unaffected by the momentous events of his time, and he continued to labour almost to the day of his death, which occurred on January 10, 1833, at Auteuil.

Turning from the story of 1752 to that of 1852, an interesting but little-known figure is that of the Finnish chemist, Johann Gadolin, who died on August 15, 1852, at the age of ninety-two, and whose biography was reviewed in *Nature* of March 9, 1911. A member of a family long associated with scholarship in Finland, he was born in Abo, of which his father became the bishop. A student under Bergmann and a friend of Scheele, in 1785 he became an extraordinary professor at Abo and in 1797 succeeded to the chair left vacant by the death of Peter Adrian Gadd, Finland's first professor of chemistry. Gadolin travelled in Germany, Holland, England and Ireland, and supported the views of Lavoisier. In 1795 he discovered the rare earth yttria, from which yttrium was obtained by Wöhler. Gadolin continued to hold his chair until 1822, by which time the port and town had passed from the control of Sweden to that of Russia. Visited in 1805 by Reginald Heber, the future bishop of India, Abo was described by him as "a place possessing an archbishop, fifteen professors, three hundred students, a ruined castle, a whitewashed cathedral and certainly the most northerly university in Europe". In 1827 the place was almost entirely destroyed by fire.

Just as Gadolin promoted the study of the new chemistry in Finland, so did his somewhat younger Scottish contemporary, Dr. Thomas Thomson (1773–1852), by his writings further the study of the atomic theory of Dalton, whom he visited at Manchester in 1804. Born at Crieff, Perthshire, Thomson attended the lectures of Black in the University of Edinburgh, and having in 1799 graduated M.D., took to writing and lecturing on chemistry and allied subjects. In 1813 he founded the *Annals of Philosophy*, which later on was merged in *The Philosophical Magazine*, and in 1818 he became the first regius professor of chemistry in the University of Glasgow. The laboratory he founded was one of the first, if not the first, for chemical research and the practical instruction of university students in chemistry, and this "at a time", said Lord Kelvin, "when an imperfectly informed public used to regard the University of Glasgow as a stagnant survival of medievalism and to call its professors the Monks of Molindinar!"

Thomson was a Fellow of the Royal Society, as also were John George Children (1777–1852), George Dollond (1774–1852), Major-General Thomas Colby (1784–1852), Gideon Algernon Mantell (1790–1852) and William Tierney Clark (1783–1852). Children, like his father (George Children (1742–1818), the Kentish banker), was known for his experiments with large galvanic batteries; but afterwards he was active as a librarian at the British Museum. He translated the works of Thenard and Berzelius, and was a secretary of the Royal Society and a founder and the first president of the Entomological Society. Dollond was for many years head of the well-known firm of opticians and instrument makers, while Colby spent nearly all his life on the Ordnance Survey of Great Britain and Ireland, of which he became superintendent in 1820. Mantell was in the front rank of geologists, and Clark was a leading civil engineer. His masterpiece was the wrought-iron chain suspension bridge over the Danube at Budapest. First used in January 1849, as a way of retreat for the Hungarians, in 1944 it was destroyed by the retreating Germans, but has since been rebuilt, much of Clark's original chains being used.

In the roll of notable physical scientists born a century ago, many countries are represented, and it includes no fewer than six Nobel prizemen—Fischer, Michelson, Moissan, Henri Becquerel, Van't Hoff and Sir William Ramsay. Emil Fischer (1852–1919) was born in Rhenish Prussia and studied at Bonn and Strassburg. After holding other positions, in 1892 he succeeded Hofmann in the chair of chemistry at Berlin, and in the following year was made a foreign member of the Chemical Society of London. In a notice of him in *Nature* of July 31, 1919, Prof. H. E. Armstrong said that when he first met Fischer in Strassburg in January 1882, "he all but fell in love with him on the spot", and that "no chemist has secured success to a greater extent through con-

stantly enforced intellectual effort and the determination, having once conceived an object, to win through". Albert Abraham Michelson (1852–1931), both Copley medallist and Nobel prizeman, was also born in Germany, at Strelno, Prussia; but was taken in infancy to San Francisco, and except for periods of study in Europe, was connected all his life with American institutions and universities. His work on optics and the velocity of light made him famous all the world over, and he was regarded as "a prince of experimentalists". Henri Moissan (1852–1907) and Antoine-Henry Becquerel (1852–1908) represent the great French men of science in the list of centenaries, the former being remembered for his isolation of fluorine, his experiments in the manufacture of artificial diamonds and his development of the electric furnace, while Becquerel's paper of February 24, 1896, entitled "Radiations émisés par Phosphorescence", forms a landmark in the story of radioactivity. The Moissan Memorial Lecture to the Chemical Society was delivered by Sir William Ramsay, and that on Becquerel by Sir Oliver Lodge. To the Paris Academy of Sciences Becquerel bequeathed 100,000 francs in memory of his famous father and grandfather, while Moissan's son, Louis, who was killed in action on August 10, 1914, left a sum of 200,000 francs to the École Supérieure de Pharmacie in memory of his father and mother. A statue of Moissan was unveiled at Meaux in 1931.

Holland's representative in the roll of honour for 1952 is the great physical chemist and pioneer of modern electrochemistry, Jacobus Hendrikus van 't Hoff, who was born at Rotterdam on August 30, 1852, and died at Steglitz, Berlin, on March 1, 1911. A student under Kekulé at Bonn and under Wurtz in Paris up to the age of forty-four, he was principally associated with Utrecht and Amsterdam, but in 1896 he became professor of chemistry in the University of Berlin, where he remained for the rest of his life. His famous British contemporary, Sir William Ramsay, was born in Glasgow on October 2, 1852, and died at Haslemere, High Wycombe, Bucks, on July 23, 1916. From the laboratories of Bunsen at Heidelberg and of Fittig at Tübingen, Ramsay returned home to become an assistant at the old Andersonian College, Glasgow. As the first professor of chemistry and then as principal, he founded the reputation of University College, Bristol, from which the present University sprang, and then in 1887 succeeded Williamson at University College, London. An acknowledged leader, the recipient of numerous honours, an international memorial fund in his honour, opened in 1917, had by 1922 reached a total of £58,000, contributions being sent to it from places as far afield as Chile, India and Japan; and on November 3, 1922, a bronze medallion tablet to his memory was unveiled in "Science Corner", Westminster Abbey, by the King, then the Duke of York.

The founding of the University of Bristol in 1909 had been preceded by the inauguration of those at Birmingham (1900), Liverpool (1903), Manchester (1903), Leeds (1904) and Sheffield (1905), all of which have been served by men distinguished in various branches of learning. The University of Birmingham owed the creation and development of its flourishing school of physics to John Henry Poynting, who was born near Manchester on September 9, 1852. A student of Owens College, Manchester, and a Fellow of Trinity College, Cambridge, from 1880 until his death on March 30, 1914, he held the chair of physics in Mason College and the University of Birmingham, and for twelve years was dean of the Faculty of Sciences. A close friend and collaborator with Sir J. J. Thomson, he was well known for his researches on electromagnetism, gravity and the pressure of light. The chair of electrical engineering at Birmingham was founded in 1904, and to it was appointed the Austrian-born engineer, Gisbert John Edward Kapp (1852–1922). Educated at Zurich, he went to England in 1875, and gradually built up an international reputation as an inventor, designer, writer and consultant. From 1894 until 1904, he was secretary and editor of the German Association of Electrical Engineers. In 1909 he was president of the Institution of Electrical Engineers, and in 1913 was president of the Engineering Section of the British Association. Owens College and the University of Manchester during this same period had as its professor of chemistry Harold Baily Dixon (1852–1930), who had succeeded Roscoe in 1886 and held the chair until 1922. He was especially known for his work on explosives and explosions, and served on various government commissions. He was twice president of the Manchester Literary and Philosophical Society, and president of the Chemical Society during 1909–11. In 1913 he received a Royal Medal from the Royal Society.

To complete the tale of centenaries of men a word or two must be said of the enthusiastic meteorologist Clement Lindley Wragge (1852–1923), who was a pioneer in making meteorological observations on Ben Nevis, in Scotland, and founded several observatories in Australia, where he was head of the Weather Bureau at Brisbane; and of the astronomer John Louis Emil Dreyer (1852–1926), who, like Kapp, was foreign born. The son of a Danish Minister of War and Marine, he was born and educated in Copenhagen and seems to have had an inborn love of astronomy. At the age of twenty-two he left Denmark for Ireland, where he was successively an assistant at Lord Rosse's Observatory, Birr Castle (1874–78), an assistant at Dunsink Observatory (1878–1882) and director of the Armagh Observatory from 1882 until 1916. His *magnum opus* was the great work in fourteen volumes containing the astronomical work and correspondence of Tycho Brahe, published by the Carlsberg Foundation of Copenhagen. A Fellow of the Royal Astronomical Society from 1875 onwards, he was awarded its Gold Medal in 1916, and in 1923 was elected president. For the last ten years of his life he made Oxford his home; he died there on September 14, 1926, at the age of seventy-four.

Of the centenaries of events which fall in 1952, such as the bicentenary of Franklin's kite experiments and the bicentenary of the adoption of the Gregorian calendar by Great Britain in 1752—when September 3 was reckoned as September 14—an important improvement affecting engineers, inventors and scientists was the passing a hundred years ago of the Patent Law Amendment Act, 1852, which "completely recast the somewhat antiquated system that had been in use during the whole of the previous three centuries". Under this Act, Bennet Woodcroft (1803–79), F.R.S., was made superintendent of specifications and then clerk to the Commissioners, and to his ability and energy Great Britain owed the publication of all specifications from 1617 to 1852, numbering 14,359, the inauguration of the Patent Office Library and the founding of the Patent Office Museum, the nucleus of the Science Museum.

ARID ZONE RESEARCH

IN 1950, the United Nations Educational, Scientific and Cultural Organization established an Interim International Arid Zone Research Council to survey the scientific problems presented by the arid regions of the world, and to consider what help might be given towards their solution. This Council met in Paris during November 1950 and put forward a programme of activities in this field. It also recommended that Unesco should set up a standing Advisory Committee on Arid Zone Research to guide the more detailed carrying out of the programme, the main outlines of which the Council had laid down. The Committee, originally of seven members and now to be enlarged to nine, was appointed and held its first meeting in Algiers in April and its second in Paris in September 1951. Its meetings are also attended by representatives of the United Nations Organization and its relevant specialized agencies, such as the Food and Agriculture Organization, and by observers from a number of international scientific bodies.

The programme covers: (1) the collection, discussion and dissemination of information already existing; and (2) assistance in specific research projects and the encouragement of co-operation between research centres. It seemed reasonable at the present stage that priority should be given to the first of these activities, since better decisions as to research projects can be made when the field of existing knowledge has been adequately reviewed.

The two principal means by which it is proposed to collect and discuss existing knowledge are reports and symposia. Each year a research field will be chosen and reports from authorities in that field will be obtained and published. In the following year a symposium on the same subject will be organized. It is proposed that each symposium should be held in a country having an arid zone and be accompanied by an excursion.

The first field chosen has been the "Hydrology of the Arid Zone with especial reference to Underground Water". Eight authors have written reports each dealing with the hydrological problems of one of the main arid areas. A symposium on this same subject has been arranged jointly by Unesco and the Turkish Government, and will take place during April 25–29, 1952, at Ankara and be followed by an excursion. The second field chosen is that of the "Plant Ecology of Arid Areas". In 1952 reports will be obtained dealing with the plant ecology of the main arid areas, and these will be followed by a symposium which it is proposed, if possible, to arrange in one of the Latin American countries. The choice of plant ecology as second subject coincides with the decision of the Institute of Biology to hold a conference in London, on the biology of hot and cold deserts, during September 1952. In 1953 the Committee proposes to survey the field of wind, solar and other energy and the possible development of their utilization in arid areas. A symposium on this subject is planned for 1954. The next subject proposed for review is that of human and animal ecology.

Other reports, not falling directly within the above scheme, will be published as occasion arises. Thus a series of 'homoclimatic' maps, setting out the principal meteorological features of the desert regions, have been prepared by Dr. Peveril Meigs. It is intended to publish these after they have been submitted for comment to the World Meteorological Organization and to the International Union of Geodesy and Geophysics. On the biological side a report on the flora of the Djebel Druze has been submitted for publication by the Rev. Paul Monterde, of Beirut, Lebanon.

Another activity on the information side is the preparation of a directory of research centres concerned with arid zone problems. This will include information as to facilities available at each centre, as well as the main fields of research in progress. Data needed for the preparation of this directory are being obtained by means of a questionnaire.

The Committee seeks also to help in the development of research centres and of their activities. It was a recommendation passed to it by the Interim Council "that suitable existing research centres dealing with the differing problems of the Arid Zone should be encouraged, by all appropriate means, to accept visiting scientists and fellowship holders from other countries, to exchange personnel and information among themselves, and to direct their activities towards a coordinated programme of arid zone research". Research centres within the arid zone differ so much in the state of their development and in the facilities available that the Committee has had to examine with great care the suitability of the various centres suggested to it for inclusion in the above scheme. It has at present selected two stations in Algeria as having suitable facilities for visiting scientific investigators and which may form a nucleus from which this scheme may be extended. One of these is the Saharan Research Centre at Beni-Abbes Oasis on the Oued Saoura, in the southern Algerian Territories, and situated about 140 miles south of Colomb-Béchar. This station was set up in 1942 by the Centre National de la Recherche Scientifique (CNRS), 1 rue Victor Hugo, Paris 5e. It is staffed by members of the Centre and also accommodates temporary workers. Facilities include laboratories for zoology, botany, geophysics and geology, botanical and other collections, a specialized library and garden plots. There are living quarters and a hotel. The second centre is the Beni Ouif Saharan Biology Station, situated in the Sud Ouranais midway between Colomb Béchar and Ain Sefra. It is at the foot of the Sahara Atlas, where a rich fauna and flora of Saharan, Moroccan and North Algerian species are found together. The station was founded in 1931 by Prof. C. Killian, of the University of Algiers, who is its director. Facilities include laboratory accommodation, collections and a library. There are living quarters and a hotel near by. It was also recommended that Unesco should assist the Fouad I Desert Institute, Heliopolis, Egypt, in preparing a research programme and in augmenting its equipment. The Committee is anxious to receive information of other research laboratories in the arid zone where facilities exist for the reception of visiting scientific workers and at which assistance might be given in co-ordinated research projects.

In the encouragement of actual research projects the Committee's immediate interest has been in problems of hydrology, since this field has been given priority during 1951. It has advised Unesco to give support to two specific investigations. The first is a study by the Research Centre at Beni-Abbes of underwater flow in the Wadi Saoura, in which this centre is situated and which provides exceptional advantages for studying this problem. The second is a study, assisted by models, of the mechanics of underground water flow in calcareous mountains, to

be undertaken by Prof. L. Picard, of the Geological Institute, Jerusalem. The Committee invites suggestions about other research projects which might suitably receive Unesco support. In evaluating suggested projects, the Committee, in addition to a consideration of their general merits, is also guided by the following criteria:

(1) The project should be of importance to several Unesco member States having arid and semi-arid areas; (2) it should come within the scope of the Unesco Arid Zone Programme at the time the project is proposed; (3) it should be of a type that can reasonably be expected to achieve definite results within a specified period; (4) if already under way, it would be completed or its value would be increased through financial aid from Unesco; (5) the results of the research project will be freely available to the public; (6) financial assistance will not be granted to defray the salaries of the permanent staff or the purchase of permanent equipment, buildings or land.

In order to help the work of the Committee, Unesco has appointed, or will appoint, in the various member States, honorary consultants who are authorities in the principal fields of arid zone research, at present including hydrology and hydro-geology, climatology, biology and sources of energy supply. These consultants, having specialized and local knowledge, will be able to assist the Committee in collecting technical information and in giving well-informed advice.

METAL ECONOMICS

IN organizing a whole-day discussion on "Metal Economics" in London on October 17, the Institute of Metals turned to a subject outside the range of its regular meetings and papers, which hitherto have almost always dealt with some aspect of the science and technology of non-ferrous metals. The innovation was justified by the obvious importance of the current crisis in metallic supplies to all concerned with technical and commercial developments in metallurgical industry. The large attendance at the morning and afternoon sessions and the close attention with which the addresses and discussion were followed demonstrated the interest of members of the Institute and visitors.

Earlier in the year the presidential address to the Institute* had been largely devoted to a plea that it should devote attention to the resources of metals on which the non-ferrous metallurgical industry is based and to the most efficient utilization of those resources. The three elements tending to produce a long-term shortage of metals are: the rate of increase in the population of the world, adding annually one per cent to its numbers; the exhaustible, non-renewable characteristic of mineral resources; and the world-wide demand for higher standards of living. It is necessary to consider what can be done to improve supplies of primary metals, how to make better use of the metals already in service and what substitutes can be used in place of the metals which have become difficult in supply.

The morning session of the meeting was devoted to "Primary Resources of Ferrous and Non-Ferrous Metals". The first paper, on "The World Supply of Non-Ferrous Metals", by R. Lewis Stubbs, secretary of the British Non-Ferrous Smelters' Association, presented the view of the primary producer. According to this, in the long-term prospect supplies of non-ferrous metals as a group will be forthcoming in quantities adequate to meet anticipated demand, although it is possible that aluminium and magnesium will constitute a larger proportion of the total consumption of non-ferrous metals than at present. The paper was strongly documented, and one interesting table is reproduced in this article (Table 1), showing the relation of stockpiling by the United States during the period 1948–50 to other normal consumption and production. The item "Total U.S. special account purchases for 3 years" is considered to represent the additions to the stockpile.

Table 1. World Production and Consumption (thousands of tons) of Copper, Zinc, Lead, Aluminium and Tin during the Three-Year Period, 1948–50

	Total production	Total consumption	Excess or deficit	Total U.S. special account purchases for 3 years	Total excess or deficit
Copper	7065	6940	+ 125	384	− 295
Zinc	5063	4868	+ 97	273	− 78
Lead	4549	4072	+ 564	354	+ 123
Aluminium	3529	3447	+ 82	31	+ 51
Tin	506	406	+ 100	107	− 7

Table 1 shows that, during 1948–50, of the world's total production 5 per cent of the copper and zinc, 8 per cent of the lead and 21 per cent of the tin were stockpiled. It is also seen that, but for stockpiling, production would have exceeded consumption in all the major non-ferrous metals. It is believed that, when the abnormal circumstances of stockpiling and re-armament have ceased, the historic processes of price mechanism will stimulate the discovery and exploitation of new ore resources and the rapid growth of declared reserves. Moreover, it is anticipated that this development will continue at a rate corresponding to the changes in demand. Referring to immediate shortages, Mr. Stubbs considers that the deficit is only a few per cent and that the rate at which new mines are being opened up affords hope that the shortage will not last much longer. An admitted difficulty here is to judge to what level the demand would rise if supplies were not restricted.

The United States and Great Britain and other countries are trying, by the agency of the International Materials Conference, to ensure a fair distribution of raw materials throughout the world. If this scheme were to break down and competitive purchasing were to be resumed, Mr. Stubbs considered that Britain would be rather badly placed because the biggest increases in metal production are in dollar areas. He suggested that, to deal with the threatened change, action should be taken along three lines: by placing long-term contracts; by encouraging production in non-dollar areas, especially in the British Commonwealth; and by fostering mining ventures with headquarters in London.

Prof. S. Zuckerman, chairman of the Natural Resources (Technical) Committee, in his paper "Metals as Natural Resources", did not share the optimism of Mr. Stubbs, observing that the disparity between supply and demand is due not to an unexpected rate of increase in demand but rather to a surprisingly slow increase in the production of primary metals. Measures to remedy this situation should include, as well as attention to intensified exploration, including domestic ores and improved efficiency of extraction and recovery, the encouragement of investment in the raw materials industry in order to

* Murphy, A. J., *J. Inst. Metals*, **79**, Pt. 3, 122 (1951).

balance the existing and projected investment in manufacturing industry. At the same time the supply of other essential imports, such as foodstuffs and textile fibres, must be maintained, and a problem exists in Britain in reconciling these competing claimants on the resources of exchange and exportable manufactures.

In his analysis of world demand and resources in the case of iron ore, Dr. T. P. Colclough, of the British Iron and Steel Federation, stated that the world production of steel in 1949 was 160 million tons. To produce this (plus foundry iron) 110 million tons of pig iron was required, in addition to about 80 million tons of scrap. The iron ore yielding the 110 million tons of pig iron amounted to 220 million tons. The United States and Canada, producing 46 per cent of the world's iron and steel, absorbed 40 per cent of the total ore consumed; Western Europe made 30 per cent of the world's iron and steel, taking 37 per cent of the iron ore; the U.S.S.R. group made 18 per cent of the iron and steel and used 17 per cent of the world output of iron ore. The countries outside these three groups accounted for 5–6 per cent of the iron and steel produced and of the ore consumed.

The United States and Canada are augmenting their ore reserves by the beneficiation of low-grade taconite, the opening up of high-grade ore fields in Venezuela and Labrador, and some importations from Sweden and West Africa. The American continent is judged to possess known resources of iron ore satisfying demands for more than a hundred years. Western Europe, including North Africa, must increase its ore supply from 80 million to 120 million tons annually to permit the desired increase of 15 million tons per year in iron and steel production. This is believed to be possible by technical improvements in the use of ore fines and by development of new African resources. Provided that the very large-scale measures planned, including special ships for transport of ore and installing blast furnaces in favourable locations, can be put into operation, Dr. Colclough believes the supplies of iron ore in America and Western Europe will keep pace with the expanding demand for steel.

In the ensuing discussion Prof. W. R. Jones, of University College, Cardiff, said that alarming predictions of imminent exhaustion of metal resources arise from a failure to distinguish between the known reserves declared by mining concerns and the true mineral wealth remaining in the earth. 'Known reserves' increase from time to time as fresh explorations are made in response to continuing or expanding demand. Prof. Jones demonstrated this with detailed returns for zinc. L. Tarring, joint editor of the *Metal Bulletin*, deplored the policy of stabilizing world prices of metals, because while ensuring remunerative levels for existing mines they might have a deterrent effect on the search for new sources to meet the requirements of the future. The attractions to investment in new mining ventures are further weakened by world-wide high rates of mining taxation. C. F. Carter, of Emmanuel College, Cambridge, joint editor of the London and Cambridge Economic Service, was not satisfied on the validity of some of Prof. Zuckerman's conclusions from the comparative data on different primary commodities; but he was impressed by the geometric progression of consumption of non-ferrous metals. E. H. Bucknall, of the Mond Nickel Co., described the procedure of the International Materials Conference, which is trying to ensure that strategic metals are distributed among the consuming countries in accordance with true needs. To achieve this the Conference is making the fullest use of technical advice, which it is invoking in deciding the measures of substitution and conservation to be required from the participating countries.

In the afternoon session, under the heading "Scrap Reclamation, Secondary Metals and Substitute Metals", papers were read dealing with measures for economizing in the use of metals. C. A. Bristow, A. J. Sidery and Dr. H. Sutton, of the Ministry of Supply, indicated the need for the engineer to make prompt use of metallurgical advances permitting savings in strategic and scarce metals—for example, niobium in stainless steel. Design of engineering components must attach more importance to the reduction of the amount of metal consumed in making each item. The segregation and recovery of scrap can be organized on a much more effective basis than at present. Corrosion represents a heavy leakage of metals which could be reduced by the correct application of known materials and methods. Substitution will rely more and more on the use of aluminium, magnesium and titanium, which offer good prospects of availability for a long period ahead.

The paper on "Economy by Standardization of Alloys and of the Method of Reclamation of Scrap Metals", by C. Dinsdale, of British Railways, gave an account of the simplification in the range of alloys used as the amalgamation of the railways in Britain progressed from a multitude of separate concerns to the present single control. In an annual consumption of thirty thousand tons of non-ferrous metals for rolling-stock, a list of thirty-seven different copper-base alloys has been reduced to five, and eighteen white-metal compositions have been reduced to four. Substantial savings are anticipated in costs of metal melting and scrap segregation, with corresponding economies in the actual consumption of non-ferrous metals.

F. Hudson, of the Mond Nickel Co., in his paper on "The Influence of Specifications on Productivity and the Economic Utilization of Ferrous and Non-Ferrous Metals", extended the theme of Mr. Dinsdale's paper to engineering industry generally. He suggested also that improvements in the quality and uniformity of castings, by permitting a reduction in present factors of safety, would lead to useful economies in metal, and that advance in the same direction would result from the greater use of high-strength alloys.

E. H. Jones, of Messrs. Capper Pass and Sons, Ltd., gave a paper on "Secondary Heavy Metals", in which he quoted the annual consumption in tons of five non-ferrous metals, other than for stockpiling, including secondaries, as follows: tin, 180,000; copper, 2,800,000; zinc, 2,100,000; lead, 2,400,000; and antimony, 50,000 tons. Table 2 shows the distribution of the consumption among different modes of application and the recovery through secondaries in each type of use. Estimates are included for the weights of metal in current use which might be reckoned as ultimately recoverable. Of the total quantity of each metal going into use each year, 32 per cent of the tin is recovered, 58 per cent of the copper, 29 per cent of the zinc, 60 per cent of the lead and 45 per cent of the antimony. The irrecoverable fractions are lost through such causes as: use in small portions as in solder and small castings, completely dispersive uses such as copper salt fungicides, lead tetraethyl (which is said to account for 10 per cent of the total consumption of lead), and sacrificial

Table 2

		Element (%)	Alloys (%)	Coatings (%)	Compounds (%)	Recovered (%)	Recoverable stock in use (mill. tons)
Tin	used	4	46	48	2	32	1·5
	recovered	2	24	6	0		
Copper	used	57	39	—	4	58	40·0
	recovered	38	20	—	0		
Zinc	used	7	45	36	13	29	11·0
	recovered	4	25	0	0		
Lead	used	40	40	—	20	60	32·0
	recovered	32	28	—	0		
Antimony	used	—	60	—	40	45	0·5
	recovered	—	45	—	0		

protective coatings. Tin is recovered satisfactorily from tinplate; but a reduction in the thickness of the tin coating might easily prevent effective recovery and result in an increased overall consumption. Other factors which can have a deterrent effect on recovery of secondaries are the insistence on unnecessarily low contents of impurity in specifications and the introduction of new alloys containing troublesome elements, such as tellurium in lead. Mr. Jones concluded by saying that reserves of the heavy non-ferrous metals, primary and secondary, are sufficient to supply the non-replaceable uses "for a time stretching well beyond that within our power to foresee".

The final paper, by Colonel W. C. Devereux, of Almin, Ltd., on the subject of "Secondary Light Metals", reviewed the development of the industry from a production by the smelters of 10,000 tons in 1935 to a rate of 160,000 tons in 1951. This represents more than a third of the total raw material used by the aluminium fabricating industry. At the present time refining of scrap for the production of pure aluminium or magnesium, though technically possible by a variety of processes, is not practised because all the metallic material coming forward can be incorporated into useful alloys. The treatment comprises sorting and fluxing to separate metallics from non-metallics. At the end of 1949 a stock of 118,000 tons of secondary aluminium alloy ingot had been built up in Great Britain, but at the present annual rate of consumption of forty thousand tons the stocks will be exhausted by the end of 1952. Current consumption of scrap arisings exceeds supply by twenty thousand tons per year. There is thus a prospect of a severe shrinkage of secondary ingot. An important factor in the future will be the slow return to use of the aluminium employed in building houses, involving 250,000 tons since 1945, and the virtual loss to Great Britain of the metal incorporated in exported manufactures. On the other hand, the increasing amount of aluminium used in packaging now becomes available for re-use in a very short cycle. Colonel Devereux's last point was that a shortage of scrap for recovery must be anticipated during the next few years, and it is of great importance to improve the efficiency of scrap salvage, collection and utilization. In the final stages of the discussion G. L. Bailey, D. A. Oliver, Dr. U. R. Evans and H. J. Miller briefly directed attention to special points.

In spite of the wide range covered by the papers and the discussions, certain clear impressions remain. The first is the confidence of the primary producers and the secondary smelters of the heavy metals that, in the long term, adequate supplies of metals will be forthcoming to meet anticipated requirements. The economists, although not pressing the contrary view strongly, appear to doubt whether this optimism has taken full account of the statistical evidence on the rapidly growing demand and of the delicate balance, at least in Great Britain, between the exportable manufactures made at home, on one hand, and the requisite imports of metals, food and other raw materials, on the other. It is not to be overlooked that, although the primary producers are hopeful of meeting any likely demand for 'non-ferrous metals' as a whole, they expect that, in achieving this, aluminium and magnesium will be substituted for some of the applications now met by the heavier metals. It was generally agreed at the conference, however, that it is well for technical metallurgists, representatives from the commercial side of the metal industry and economists to exchange views, and it would not be surprising if more meetings of the same kind were to be called for in the future.

A. J. Murphy

OBITUARIES

Prof. Allan Ferguson

Allan Ferguson, who died peacefully on November 9 at his home in Bishop's Stortford after a long and distressing illness, was born at Entwistle, near Bolton, on May 11, 1880. His scientific career began with his entry at the age of twenty-two as an exhibitioner to the University College of North Wales, Bangor, where, after graduating, he became assistant lecturer in physics in 1905, and held this post until 1919. After two years as lecturer in physics in the Manchester College of Technology, and having taken the degrees of M.A.(Wales) and D.Sc.(London), he joined the physics staff at East London (later Queen Mary) College. He retired in 1945 with the status of assistant professor and Fellow of the College.

Ferguson's special scientific interest was in general physics, particularly surface tension, and he made important theoretical and experimental contributions in this field. As a teacher he was outstanding, armed as he was with profound knowledge and exceptional power of imparting it lucidly to his students, with whom he was most popular. He will be remembered, perhaps best, for the large part he played in promoting scientific publication. The Physical Society especially owes him much. He was president during 1938–41, having been previously papers secretary for ten years; and it was he who was chiefly responsible for the initiation in 1934 of the Society's Annual Progress Reports, which he edited for the first six years. He

was also closely associated with the British Association, of which he was a general secretary from 1936 until 1946, and president of Section A in 1936. Other activities were his work as editor of the *Philosophical Magazine* from 1937 to 1948, as a member of the editorial panel of *Endeavour* from its commencement, and as advisory editor of *Nature* during 1939–40.

As a man Ferguson was great both in body and in spirit, abounding in good nature and good humour. He was a voracious reader and a lover of the best books—which enabled him always to be ready in conversation with an apt quotation or reminiscence. He was truly a good companion. But to the writer the most notable thing about him was his fortitude in adversity, to which he fell victim in his later years. The first onset was in 1933, when threatening blindness necessitated an operation for cataract, followed the next year by one for retinal detachment. This impairment of his sight hindered his reading which meant so much to him, yet he was not dismayed. Then in 1942 the malady to which he eventually succumbed began to rob him of his powers of locomotion and speech, and, after his retirement from Queen Mary College, he became more and more confined to his home. Yet, although an invalid and gradually deteriorating physically, he remained until the very end alert in mind, and managed to continue some of his reading and editorial work. Visits from friends were a source of stimulus and happiness to him; they, on their part, never left him without wondering how so brave a heart could dwell in so feeble a body. His wife Nesta, whom he married in 1919, and who by her loving care did all that was humanly possible to ease his discomforts, survives him; so does their son John. A. O. Rankine

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We regret to announce the following deaths:

Sir Peter Buck, K.C.M.G., emeritus professor of anthropology in Yale University, and director for many years of the Bernice P. Bishop Museum, Honolulu.

Sir Cyril Sankey Fox, during 1939–43 director of the Geological Survey of India, on December 28, aged sixty-four.

NEWS and VIEWS

New Year Honours

The New Year honours list includes the names of the following scientific workers and others associated with scientific work:

Viscount: Sir John Anderson.

K.C.B.: Dr. Harold P. Himsworth, secretary of the Medical Research Council.

K.B.E.: Acting Air Marshal C. W. Weedon, R.A.F.

Knights: Dr. George V. Allen, vice-chancellor of the University of Malaya; Prof. Leonard Bairstow, chairman of the Aeronautical Research Council; John L. Blake, comptroller-general of the Patent Office; John P. Bowen, lately engineer-in-chief to the Corporation of Trinity House; Dr. Walter Russell Brain, president of the Royal College of Physicians; Prof. Rudolph A. Peters, Whitley professor of biochemistry, University of Oxford; Dr. David R. Pye, lately provost of University College, University of London.

C.B.: R. Rae, director of the National Agricultural Advisory Service, Ministry of Agriculture; Major-General Colin Bullard, Corps of Royal Electrical and Mechanical Engineers.

C.M.G.: Walter Adams, secretary of the Inter-University Council for Higher Education in the Colonies; Dr. K. A. Davies, director of the Geological Survey of Uganda; A. de K. Frampton, agricultural adviser to the Comptroller for Development and Welfare, West Indies; S. Gillett, lately director of agriculture, Kenya, now chairman and general manager, Overseas Food Corporation, Kongwa, Tanganyika.

C.B.E.: Dr. G. L. Bailey, director of research, British Non-Ferrous Metals Research Association; Prof. B. T. P. Barker, emeritus professor of agricultural botany, University of Bristol; R. Boutflour, principal of the Royal Agricultural College, Cirencester; W. H. B. Buckhurst, director of lands, mines and surveys, Fiji; L. B. Bull, for services to science in Australia; Dr. J. M. Cowan, assistant to the regius keeper of the Royal Botanic Gardens, Edinburgh; I. H. Cox, lately director of science, Festival of Britain; Acting Air Commodore C. L. Dannl R.A.F.; V. P. A. Derrick, chief statistician, General Register Office; Dr. A. J. K. Esdaile, for services to librarianship and bibliography; F. St. A. Hartley, keeper, Science Museum; Dr. H. Hartley, chairman of Radiation, Ltd.; Prof. T. P. Hilditch, lately Campbell-Brown professor of industrial chemistry, University of Liverpool; Dr. F. M. Lea, director of the Building Research Station (Department of Scientific and Industrial Research), Garston, nr. Watford; A. E. H. Masters, chief scientific officer, Fighting Vehicles Design Establishment, Ministry of Supply; M. H. Neale, lately a member of the Scientific Fishery Research Committees of the Development Commission; M. W. Perrin, lately deputy controller, Atomic Energy Division, Ministry of Supply; Dr. D. Rebbeck, lately deputy chairman, Northern Ireland Festival Committee; N. D. Riley, keeper of entomology, British Museum (Natural History); Instructor Captain R. E. Shaw, R.N.: H. L. Stevens, principal director of equipment, research and development (air), Ministry of Supply; Brigadier R. P. Wheeler, deputy director general and director of field survey, Ordnance Survey Department; T. H. Windibank, director of Crompton Parkinson, Ltd.; Dr. A. Winstanley, deputy chief inspector of mines for special development duties, Ministry of Fuel and Power.

Royal Society Research Professor: Mr. A. L. Hodgkin, F.R.S.

Mr. A. L. Hodgkin, assistant director of research in the Physiological Laboratory, University of Cambridge, who has recently been appointed a Royal Society Research Professor, has already won an international reputation for his work on the biophysics of nervous conduction. His name is associated with the two most striking advances made recently in this field: the definite proof that in a nerve fibre the electric forces at the active region play an essential part in the transmission of the active state; and the discovery that the active surface develops a positive potential with respect to the interior of the fibre.

For many years physiologists had taken Bernstein's membrane hypothesis of nervous conduction as highly probable, but in 1937 Hodgkin supplied convincing evidence of its central tenet, namely, that the change of potential at the active surface induced the activity of neighbouring regions. But two years later, Hodgkin and Huxley found that the change of potential at the active surface was too large to be explained by a general increase in permeability and implied a reversal of the selective permeability of the resting membrane. This new and important fact, found independently by Cole and Curtis in the United States, has now been established for excitable cells in general. It has led to a general attack on the biophysics of the cell membrane and on the differences in ionic concentration inside and outside the cell. After the War, Hodgkin returned to Cambridge to direct a research unit supported by the Rockefeller Foundation. He is a Fellow of Trinity College, Cambridge, and was elected to the Royal Society in 1948.

Wilhelm Homberg (1652–1715)

Wilhelm Homberg, who was born in Batavia, Java, three hundred years ago, on January 8, 1652, has enriched chemistry with original observations and discoveries, some of which, despite their alchemical flavour, have stood the test of time. His father, who came from Quedlinburg in Germany, had joined the Dutch East India Company and had been appointed commandant of the Batavia arsenal. Wilhelm, the second of his four children, was intended for the army and was made a corporal at the age of four. When the family returned to Europe, he studied law in Jena and Leipzig, and in 1674 became an advocate in Magdeburg. It was Otto von Guericke who first aroused his interest in the natural sciences. Giving up the law, Homberg travelled extensively, studying medicine and botany in Padua, chemistry in Bologna and in England under Robert Boyle, and anatomy in Leyden. After taking the M.D. at Wittenberg, he practised medicine in Rome for five years. In 1691 he settled in Paris, becoming a member of the Academy of Sciences and director of its chemical laboratory, and later private physician to the Duke of Orleans. He died on September 24, 1715. Possessor of an insatiable curiosity, a lively mind, and dexterous hands, Homberg made many contributions to chemistry, astronomy, pharmacy and therapeutics. He was keenly interested in the phosphorescent substances, and popularized the use of 'phosphorus'— discovered, but kept a secret, by the Hamburg alchemist Brandt. For long, fused calcium chloride was known as 'Homberg's phosphorus'. In 1702 he discovered boric acid, which was called *sal sedativum Hombergi*. He also recorded observations on the green colour produced in flames by copper, on crystallization of common salt, and on the gain in weight of antimony when submitted to solar calcination. Much of his work was published in the *Recueil de l'Académie des Sciences* between 1692 and 1714. With the iatrochemist Nicolas Lémery, Homberg shares the distinction of having introduced chemistry into France.

New Satellite of Jupiter

On September 29, 1951, Dr. Seth B. Nicholson, while examining a plate exposed earlier that night, discovered an object which he thought was a new satellite of Jupiter. No announcement was made until the object had been photographed later on three occasions with the 60-in. telescope at Mount Wilson and also with the 100-in., with which Dr. Nicholson had made the first photograph. Although it was obviously moving with Jupiter, there was no certainty that it was a new satellite. and computations made by Dr. P. Musen of the Cincinnati Observatory indicated that it might be the tenth satellite of Jupiter; but this view was later shown to be incorrect. Harvard College Observatory Announcement Card 1160, dated November 21, 1951, gives approximate elements of the orbit of the object, which is now accepted as the twelfth satellite of Jupiter, from which it appears that its mean distance from the planet is almost 13 million miles, or about a million miles less than that of Jupiter XI. The eccentricity of the orbit is 0·13456 and its inclination to the ecliptic is 147° 21′, so that four of Jupiter's satellites have retrograde motion. The magnitude of the new satellite is 18·3, but this is only a provisional figure; its diameter has been estimated to be about 15 miles— the diameter of satellite X. Dr. Nicholson now ranks with Galileo as the only astronomer who has discovered four of Jupiter's satellites.

The Balliol–Trinity Laboratory and Science Library, Oxford

On December 14, Sir Harold Hartley opened a new science library which has been constructed as part of the Balliol College War Memorial in the premises formerly occupied by the Balliol-Trinity Laboratories. The library is for the use of both Balliol and Trinity Colleges, and continues a long tradition of collaboration which has contributed much to the development of science in Oxford. This collaboration dates from 1879, when a joint scheme was set up for the teaching of science, and a door (known as the 'scientific frontier') was opened to give Trinity men access to the lecture room and laboratories in Balliol. The latter were situated in cellars, one of which had been in use as a chemical laboratory since 1851: it was used by Sir Benjamin Brodie (Waynflete professor of chemistry during 1855–73) for his work on ozone. The Laboratories soon acquired more premises in both Colleges, and although the accommodation was cramped and primitive, much valuable work was done both in teaching and research. Originally, the Laboratory was used to teach all branches of physics and chemistry to undergraduates of both Colleges; but most of the research done there was physico-chemical in nature, and during its latter years it provided most of the physical chemistry teaching for the whole of the University of Oxford. The Laboratories closed in 1941 on the completion of the University Physical Chemistry Laboratory: they were almost the last of the College laboratories to survive in Oxford, being outlived only by the Sir Leoline Jenkins Laboratory in Jesus College. Among those who have worked in the Balliol–Trinity Laboratories are Sir Benjamin Brodie, Vernon Harcourt, Sir John Conroy, H. B. Dixon, H. B. Baker, D. H. Nagel, Sir Harold Hartley, H. G. J. Moseley and Sir Cyril Hinshelwood. His many friends will be glad to hear that the opening of the library was attended by James Warrell, who served as laboratory steward for more than fifty years.

Eighth International Congress on Theoretical and Applied Mechanics, Istanbul

The Eighth International Congress on Theoretical and Applied Mechanics, which is sponsored by the International Committee for the Congresses of Applied Mechanics, will be held in the University of Istanbul

during August 20–28. Membership of the Congress, which is open to all qualified persons, will cost 10 dollars. Members may present two papers only, each not exceeding fifteen minutes in duration, and abstracts, not more than four hundred words in length, must be sent on the correct forms to the organizing committee not later than June 1; members of the Congress who will not be able to attend in person may send only one paper. Five minutes will be allowed for discussion after the reading of each paper. The official languages of the Congress are English, French, German and Italian. The Congress will be divided into five sections, dealing with the following subjects: (1) elasticity, plasticity and rheology; (2) fluid mechanics (aerodynamics and hydrodynamics); (3) mechanics of solids (ballistics, vibrations, friction and lubrication); (4) statistical mechanics, thermodynamics and heat transfer; (5) mathematics of physics and mechanics, and methods of computation. A few outstanding personalities will be invited to deliver addresses, and there will also be a lecture by a specialist in each section of the Congress, mainly in order to present research in fields in which great advances have been made in recent years. A large number of official functions, excursions, etc., will be arranged. Further information concerning travel and accommodation can be obtained from the American Express Company, Inc. (London address: 6 Haymarket, London, W.C.2), which is the official travel agency for the Congress. All communications dealing with Congress matters should be addressed to the secretariat at P.O. Box 245, Istanbul, Turkey.

City and Guilds of London Institute: Fellowships

THE Council of the City and Guilds of London Institute have conferred the fellowship of the Institute on the following past students of the City and Guilds College: Mr. Atholl Blair and Mr. Harry Shoosmith. Mr. Blair has spent his working life with Harland and Wolff, of Belfast, where he is manager of the Engine Works, and a director since 1934. He has been concerned with the construction and installation of machinery in all steam and diesel vessels built at Belfast, and has published several articles on marine propulsion, the diesel engine and on educational matters connected with the shipbuilding industry. Mr. Shoosmith has been associated with the Willan and Robinson works at Rugby, G. Kynock and Co., Ltd., Birmingham, Priestman Brothers of Hull, and Wm. Cory and Son, Ltd. As chief engineer of Cory's he was responsible for the design and construction of all types of coal and oil handling plant, loading stations and craft used in the industry. In 1934 he left Cory's and has since practised as a consultant with a world-wide reputation in his particular field of fuel handling.

Institution of Naval Architects

THE Institution of Naval Architects is offering a scholarship in naval architecture, worth £175 a year, which is open to British apprentices or pupils, less than twenty-three years of age, in the Royal Dockyards or private shipyards; entries close on January 15. The Institution is offering three other scholarships, also of £175 a year, to British subjects less than nineteen years of age, the entries for which close on May 31: a Trewent scholarship in naval architecture for apprentices or pupils in private shipyards; and a Denny scholarship in naval architecture and one in marine engineering, tenable for four years at the University of Glasgow, with apprenticeship of five years, for those who have not yet begun their apprenticeship. Further particulars of the scholarships can be obtained from the secretary of the Institution at 10, Upper Belgrave Street, London, S.W.1.

The Night Sky in January

FULL moon occurs on Jan. 12d. 04h. 55m., U.T., and new moon on Jan. 26d. 22h. 26m. The following conjunctions with the moon take place: Jan. 3d. 20h., Jupiter 5° S.; Jan. 19d. 09h., Saturn 7° N.; Jan. 20d. 12h., Mars 7° N.; Jan. 24d. 07h., Venus 6° N.; Jan. 25d. 16h., Mercury 3° N.; Jan. 31d. 12h., Jupiter 5° S. Mercury is a morning star, rising at 6h. 20m., 6h. 45m. and 7h. 20m., on January 1, 15 and 31, respectively, but towards the end of the month it is too close to the sun for favourable observation. Venus, a morning star, rises at 4h. 40m., 5h. 15m. and 5h. 45m., on January 1, 15 and 31, respectively, stellar magnitude $-3{\cdot}5$ and the visible portion of the illuminated disk varying from 0·71 to 0·80. Mars is a morning star, rising at 1h. 15m., 1h. and 0h. 35m. on January 1, 15 and 31, respectively; in the early part of the month it lies a little north of the bright star Spica (α Virginis). Jupiter sets at 23h. 50m. on January 1 and 22h. 15m. on January 31, during which time its stellar magnitude varies between -2 and $-1{\cdot}8$. Saturn, a morning star, rises at 0h. 40m., 23h. 45m. and 22h. 40m. at the beginning, middle and end of the month, respectively. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Jan. 7d. 20h. 21·8m., q Taur. (D); Jan. 7d. 20h. 25·3m., 18 Taur. (D); Jan. 7d. 20h. 43·8m., 21 Taur. (D); Jan. 14d. 20h. 32·3m., ψ Leon. (R); Jan. 17d. 04h. 54·7m., 79 Leon. (R); Jan. 29d. 18h. 46·7m., 293B. Aquar. (D). D and R refer respectively to disappearance and reappearance. The earth reached perihelion on January 4.

Announcements

PROF. J. C. ECCLES, professor of physiology, University of Otago, will deliver the Waynflete Lectures at Magdalen College, Oxford, on Fridays, beginning January 25. He will speak on "The Neurophysiological Basis of Mind".

A NATIONAL conference on "Science for Peace" will be held in the Holborn Hall, Grays Inn Road, London, W.C.1, during January 19–20. The conference will be divided into three sessions, during which proposed general principles will be presented by F. le Gros Clark, organizational proposals by Prof. Kathleen Lonsdale and a summing-up and closing remarks by Prof. C. F. Powell. Further information can be obtained from Dr. A. H. Gordon, *Science for Peace*, 49 Flower Lane, London, N.W.7.

A SYMPOSIUM on the physical chemistry of molten oxides, sulphides, silicates and other salts will be held on February 20 by the Nuffield Research Group in Extraction Metallurgy at the Royal School of Mines, London. Particular attention will be paid to slags and mattes of importance in metal extraction. Further details can be obtained on application to Dr. F. D. Richardson, Department of Metallurgy, Royal School of Mines, Prince Consort Road, London, S.W.7.

WE regret that in *Nature* of December 29, p. 1114, the name of H.M. Astronomer at the Cape of Good Hope was incorrectly printed; his name is Dr. R. H. Stoy.

A PHYSICAL METHOD FOR DETERMINATION OF THE MOTILITY AND CONCENTRATION OF SPERMATOZOA

By C. A. BOSSELAAR
Laboratory of Physics, University of Utrecht
AND
N. SPRONK*
Zoological Laboratory, Dept. of Endocrinology, University of Utrecht

In connexion with artificial insemination, it is necessary to be able to determine exactly the motility and the concentration of the sperm cells in an ejaculate. The study of the problems related to this led to the development of a new physical method. Though especially suitable for measuring the motility and concentration of bull's sperm, our method is also applicable to the study of motility, velocity and concentration of any microscopical particles. The discussion of the method will be restricted here to the measurement of the motility of bull's sperm.

Many attempts have been made to obtain an objective method for determining wave formation and motility of semen samples. The methods for studying wave formation are mostly very subjective, and depend largely on the routine of the investigator. In ejaculates with high fertility the swimming sperm cells cause many waves, whereas in ejaculates with low fertilizing capacity no waves are formed. To avoid subjectivity, Lord Rothschild[1] developed his electrical method, the principle of which depends on the fact that the semen has a higher impedance than the medium in which it is immersed. An objection to this method is that the number of fluctuations shown by the oscillograph on the screen is ordinarily not established by a counter but estimated by the human eye.

Van Zijl[2] has published an account of an objective method of determining the motility of sperm cells, depending on the distance covered by a sperm cell in 30 min. However, this method has the disadvantages that it is difficult to estimate the main distance covered by a sperm cell objectively, and that the speed of only the most rapid sperm cells is taken into account.

We believe there is no good objective method of measuring sperm motility. With any such method it must be possible: (1) to obtain reproducible results; (2) to apply it to concentrated as well as to diluted semen samples; and (3) independent control of the properties of the apparatus used is very desirable.

With regard to the last point it is obviously necessary to link the new method with others which have been used in the past. The principle of our method depends on the replacement of the subjective human microscopical observation by an objective physical one.

With the aid of a microscope (Fig. 1) magnifying, for example, 400 times, an image of the sperm cells is projected on to a screen (marked 5 in Fig. 1), on which the sperm cells produce light signals. In order to obtain a good signal-to-background ratio a dark-field condenser (2) is used. If the distance between the microscope and the screen is 10 cm., an image of a single sperm cell is visible with the naked eye. In the screen an aperture (6) is made, behind which a photomultiplier (9) is placed. The diameter of the diaphragm is of about the same order as the dimension of the projected image of a sperm cell. If a swimming sperm cell is crossing this aperture its light falls on the multiplier which in turn gives a voltage pulse. The more mobile the sperm sample is, the more sperm cells pass the opening of the diaphragm in a fixed time. Of course, the concentration of the preparation must also be taken into account. The thickness of the preparation must be held constant.

The voltage fluctuations, originating from the sperm cells crossing the opening, are counted with the aid of an electronic counter (11) based on the 'scale-of-two' principle. Our counter has a maximum speed of 40 counts to the second. To amplify these frequencies between 0 and 40 Hz., it is possible to use a direct-current amplifier; but to avoid deviations caused by false light, mains' hum and the unreliability of a direct-current amplifier, the light is interrupted 375 times a second by a perforated revolving disk (8). The multiplier then gives an alternating voltage of 375 Hz. modulated by the frequencies arising from the motility of the sperm cells. Consequently, an alternating-current amplifier (10) with a band-width of 80 Hz. can be used. After amplification a detector stage equalizes the voltage again, and so we get an output voltage which is proportional to the light-intensity on the photomultiplier. It was found that under these conditions the light of one single sperm cell causes a voltage pulse which is large in relation to the noise and other disturbances.

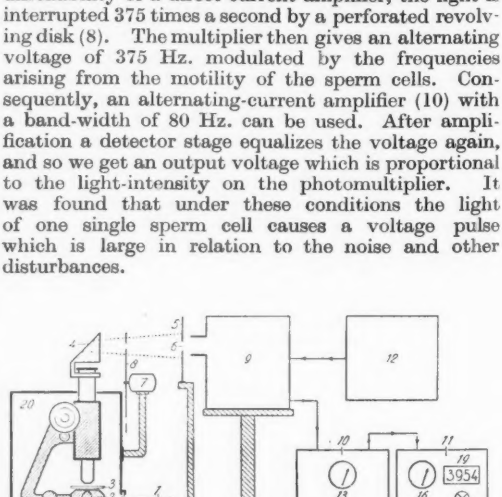

Fig. 1. Diagram of the apparatus. 1, Microscope lamp; direct current is used to avoid mains' hum and intensity fluctuations; 3, slide; 4, projection prism; 7, motor; 9, photomultiplier and first amplifier tube; 12, high-voltage supply; 13, meter output-voltage amplifier; 14, switch regulating amplification factor; 15, button for adjusting the sensitivity; 16, meter indicating bias voltage; 17, regulator for bias voltage; 18, neon lamp indicating which valve of the scale-of-two is conducting; 19, mechanical counter register; 20, case maintained at 37° C.

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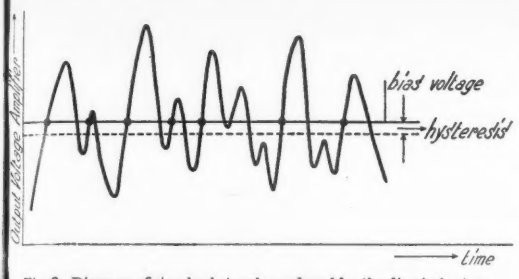

Fig. 2. Diagram of standard signals produced by the discriminator. Times at which a standard signal originates are indicated by circles

In the counter apparatus a so-called Schmitt discriminator is used. If the voltage on the first grid of the discriminator exceeds a certain bias voltage, the discriminator gives a standard signal which is counted by the counter; the counter contains one 'scale-of-two' stage and one power stage, and drives a mechanical counter register. If the voltage on the first grid decreases by more than the amount of the so-called hysteresis under the bias (in order to reset the discriminator) and after that exceeds it again, a new standard signal originates (Fig. 2).

The bias can be adjusted, so that with the same apparatus, fluctuations caused by one single sperm cell can be counted, as well as those caused at the same moment by a number of cells. To measure the motility it is necessary to count a number of fluctuations in a given time with a suitable diaphragm aperture, bias voltage, and amplification factor; together with the measurement of concentration, these results may give a good measure of the motility.

The concentration is determined in the following way. With a large aperture in the screen and a low magnification of the microscope, the light scattered by a large number of sperm cells falls on the photomultiplier; then the output voltage of the amplifier is a measure of the concentration of a sperm sample.

The whole microscope is maintained at 37° C., because the immersion oil between the dark field condenser and the slide is responsible for considerable heat transport from the slide to the condenser.

In discussing our method, it can be said at once that there is no doubt about its objectivity. It is possible to control the sensitivity of the apparatus by placing a frosted glass on the microscope stage; then the amplifier should give a standard output voltage.

As fluctuations caused by a concentrated preparation as well as those originating from one single sperm cell can be measured, it is evident that the method is applicable to concentrated as well as to diluted samples of semen.

When we were building up the apparatus it was very desirable and also possible to see what happened in the preparation by projection on the screen, and to compare the observations with the reactions of the electronic apparatus.

Some objections to this method can be made. (1) Dead sperm masses might affect the measurement of motility; but in our apparatus only moving particles are counted. (2) The apparatus is not able to distinguish abnormal movements, such as circular movements or the movements of two or more sperm cells swimming together forward or backward. This is true; but then the investigator has to decide about the character of the movements. (3) The photomultiplier cannot distinguish whether it is the same or another sperm cell which passes the opening. This objection can, of course, be made against all methods of determining the motility of sperm cells.

Details of our experiments will be published elsewhere.

This research took place under the auspices of the Unit for Research on Animal Husbandry, T.N.O. The hospitality of Prof. J. M. W. Milatz made it possible to work in the Physical Laboratory, Utrecht. We are also indebted to Prof. J. T. Randall for reading the manuscript.

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NATURE OF THE CIRCULATING THYROID HORMONE - PLASMA PROTEIN COMPLEX

By A. H. GORDON, J. GROSS*, D. O'CONNOR and ROSALIND PITT-RIVERS

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IT is now generally agreed that the biologically active fraction of the iodine in plasma is thyroxine itself[1–3], possibly together with another unidentified iodine-containing compound which has been demonstrated in the plasma of animals[4] and man[5]. Iodine determinations on plasma protein fractions[2,6,7] have indicated that the albumin fraction contains most of the iodine, although some is found in the α- and β-globulin fractions in high concentration. Experiments[8] on the binding of radioactive thyroxine by similar plasma protein fractions have indicated that the α-globulin present as a contaminant in the albumin and β-globulin fractions might be the actual binding protein. In order to obtain more definite information as to the nature of the binding protein, the following experiments were attempted.

Paper electrophoresis was carried out on nine samples of serum (or plasma) from patients who had received radioactive iodine. Of these, three were clinically euthyroid and had received 100 mC. of iodine-131 for the treatment of thyroid carcinoma, while the fourth was hyperthyroid and had received a 5-mC. dose of radioiodine. The serum was collected at intervals from 2 hr. to 4–5 days after administration of iodine-131. The electrophoretic procedure was a modification of the technique described by Durrum[9]. A strip of a special Munktell 20 paper (cf. Cremer and Tiselius[10]), 20 mm. × 500 mm., was dipped in $M/20$ veronal buffer at pH 8·5 and blotted. Twenty microlitres of serum was applied as a spot to the damp paper, which was then suspended on two glass rods fixed over the two beakers containing buffer, so that the serum spot was located between the rods about one inch from that rod over the cathode (see Fig. 1). The whole assembly was covered with a large glass jar and after half an hour a potential of 5 volts/cm. of paper was applied for 18 hr. The strip was then allowed to dry at room temperature and placed on an automatic counter assembly which counted successive 4·5-mm. bands of the paper.

* Merck Fellow in the Natural Sciences of the National Research Council of Canada.

Those samples which contained sufficient activity were then autographed by being placed against a sheet of X-ray film with an intervening sheet of 'Cellophane'. After these procedures, the protein bands were made visible with bromphenol blue (Fig. 2), again according to the method of Durrum, and their positions compared with that of the radioactivity.

In all the sera examined, the maximum concentration of radioactivity was found in a band immediately following the albumin band (Fig. 2*a* and *b*), with a much smaller amount associated with the albumin fraction. Paper chromatographic analysis of the radioactive material present in these samples showed that most of the iodine-131 was present as iodide or as thyroxine[5]. Further experiments were therefore carried out in which synthetic radio-thyroxine of high activity and radioactive sodium iodide were added to normal human serum, and the positions of the radioactivities were again determined. Trace amounts of sodium iodide-131 alone migrated more rapidly than any of the protein bands and, when mixed with serum, about 5 per cent of the radioactivity added remained associated with the albumin band. Radio-thyroxine in the absence of serum proteins migrated as shown in Fig. 2*e*. When, however, radio-thyroxine (0·15 γ, 0·5 μC./ml. of serum) was added to serum *in vitro*, most of the radioactivity was detectable as a band (Fig. 2*c* and *d*) occurring in the same position as that due to the circulating radioactivity in the experimental sera (Fig. 2*a* and *b*). The serum used in the *in vitro* experiments was then subjected to electrophoresis with veronal buffer at *p*H 8·5, in the Tiselius apparatus. The pattern obtained (Fig. 2*f*) was enlarged photographically so that the centres of the albumin and γ-globulin peaks would correspond with the centres of the same protein bands on the paper; it can be seen that all the protein peaks then corresponded with the equivalent bands on the paper.

By comparing Figs. 2*c*, *d* and *f*, it is evident that radio-thyroxine is associated with one or more serum constituents having mobilities at *p*H 8·5 close to that of α_1-globulin. It may be relevant that a lipoprotein has been found with a very similar mobility[11].

These results suggest that the thyroid hormone secreted from the gland may well be largely associated with a single plasma protein constituent. In this case the results of previous investigators who found concentrations of iodine[2,6,7] and thyroxine-binding capacity[8] in several fractions obtained by Cohn's procedure[12] are probably due to incomplete separation of the plasma constituents.

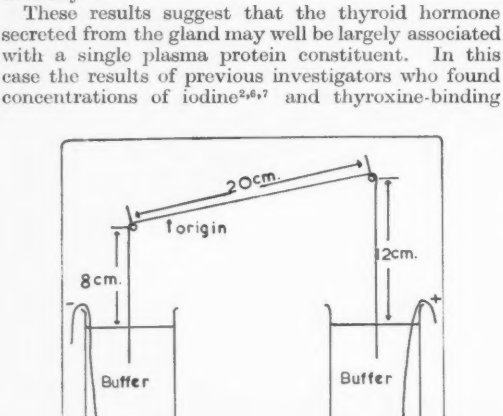

Fig. 1. Schematic diagram of the electrophoresis apparatus, drawn to scale. The arrow marked 'origin' indicates the position of the serum at the beginning of the electrophoretic run

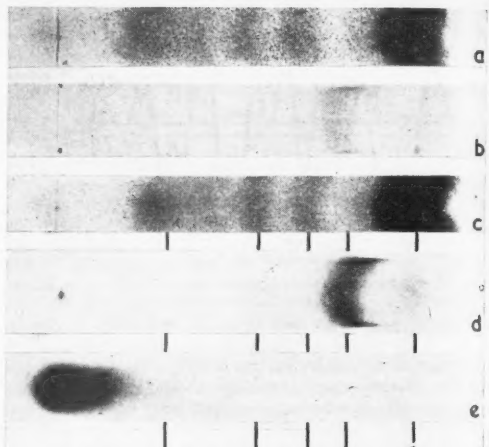

Fig. 2. (*a*) Distribution of serum proteins after the electrophoresis on paper of 0·02 cm.³ of serum from a euthyroid subject five days after the administration of 100 mC. of sodium iodide-131 for the treatment of thyroid carcinoma.

(*b*) Autoradiograph obtained by placing strip (*a*) in contact with X-ray film. The position of the serum radioactivity is indicated by the darkening of the film and is mainly concentrated in a band immediately following the albumin area. A faint darkening corresponding to the albumin area itself is visible on the original film, although not clearly apparent in photographic reproduction.

(*c*) Electrophoretic paper diagram of 0·02 cm.³ of serum, from an untreated euthyroid subject, to which radioactive thyroxine had been added prior to electrophoresis.

(*d*) Autoradiograph of strip (*c*) showing a similar distribution of radioactivity as in (*b*).

(*e*) Autoradiograph of a paper electrophoresis of the radioactive thyroxine alone.

(*f*) Electrophoretic pattern obtained in the Tiselius apparatus of the serum shown in (*c*).

We are indebted to Dr. E. E. Pochin and Dr. N. B. Myant for the blood samples, to Mrs. A. Dovey for carrying out the electrophoresis of the serum in the Tiselius apparatus and to Mr. C. Sutton and Mr. E. Hitchcock for the preparation of the autoradiographs and photographs. [Sept. 24.

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FACTORS AFFECTING THE INCIDENCE OF CLUB ROOT DISEASE OF BRASSICÆ

By Dr. JOHN COLHOUN

Ministry of Agriculture for Northern Ireland, Plant Pathology Division, The Queen's University, Belfast

ALTHOUGH club root disease has been studied by many workers during the past two hundred years, our knowledge regarding the disease and its causal organism, *Plasmodiophora brassicæ* Woron., is still very imperfect. As a result of field observations it has long been recognized that a number of factors affect the incidence and severity of the disease, but considerable disagreement still exists regarding the effects of certain factors.

Following experiments carried out under controlled soil conditions, it is now generally accepted that in acid soils the optimum conditions for infection and the development of the disease are a soil moisture of 70–80 per cent of the maximum water-holding capacity and the temperature falling within the range 18–25° C.[1–3]. Agreement has not, however, been reached regarding the conditions which permit of the occurrence of the disease in alkaline soils, and the limits of the *p*H range for soils in which the disease occurs are also indefinite. While the disease often develops readily in alkaline soils in the field, many workers[3–6] have reported that infection is prevented, or greatly inhibited, when such soils are employed in pot experiments. Thus Chupp found the upper limit for infection of cabbages in greenhouse experiments to be *p*H 7·2–7·4, and at *p*H 7·1–7·5 Lindfors recorded that only 8·5 per cent of the plants were diseased. According to Larson and Walker[7], the disease readily developed in the field after liming had raised the soil *p*H to 7·1, but no symptoms developed when cabbages were grown in the same soil in pots under conditions of low, intermediate or high constant moisture-levels. However, they found that fluctuation of soil moisture within a low range, or forced aeration of the soil, permitted a considerable number of plants to become infected in the treated soil in pot experiments. Haenseler[8] suggested that uneven distribution of soil acidity might be sufficient to account for the occurrence of infected plants under field conditions.

Biological techniques have already been evolved in Northern Ireland for the evaluation of seed disinfectants for the control of *Helminthosporium* disease of oats[9] and of seed-borne diseases of flax[10]. During the course of further experimental work planned to enable the biological testing of soil fungicides for the control of *P. brassicæ* to be undertaken in a greenhouse, I attempted to repeat certain experiments made with alkaline soils by Larson and Walker. When cabbages were transplanted into naturally contaminated soils under the moisture conditions employed by Larson and Walker, the plants failed to become established in the very dry soil, so tests could not be carried out with the soil moisture fluctuating within the low range which they found favoured infection. Further experiments were made using water-tight containers of the type previously employed by Muskett[11] and with naturally contaminated soil from a garden which had been treated with various forms of lime over a period of years. The *p*H value of the soil in a portion of the garden was 7·8, while that of the remainder was 6·3. Susceptible cruciferous crops had been grown in the garden for many years, and severe attacks occurred even in the alkaline soil. Within four weeks of being transplanted into soil of *p*H 6·3 contained in pots, all the cabbages of the variety Enfield Market showed the development of large clubs on their roots when the conditions generally accepted as being favourable for infection in acid soils were provided. It was also found that severe attacks of the disease could occur when seedlings were transplanted into pots containing soil of *p*H 7·8 and then subjected to different levels of temperature and relatively constant soil moisture.

However, temperature and soil moisture were shown to exercise a greater influence on the occurrence of infection in the alkaline than in the acid soil. In both soils severe infection occurred at a moisture content of 70 per cent of the maximum water-holding capacity. At *p*H 7·8 a high incidence of the disease appeared only when a mean air temperature of 25° C., or even higher, was provided for a number of days in the early stages of growth. At *p*H 6·3 a considerable number of plants were infected when the average air temperature was in the neighbourhood of 20° C. or even lower. Only one experiment was made with pots of the alkaline soil maintained at a constant temperature (23° C.). Of the plants so treated, 41 per cent were found to be infected four weeks after being transplanted. In other experiments, where plants were grown in similar soil in the greenhouse with the air temperature frequently much higher than 23° C., practically all the plants were infected.

It may therefore be concluded that the optimum temperature for infection in alkaline soils is higher than 23° C. It is possible, however, that if the soil temperature reaches a high enough level for a short time this may be adequate to enable infection to occur in the alkaline soil. Temperatures and soil moisture contents lower than the optima permitted the development of lower numbers of infected plants. At certain levels, determined by the interaction of these two factors, no infection occurred. When fluctuating soil moistures were employed, the higher amounts of infection were associated with high moisture contents.

The experimental work referred to above was carried out prior to 1939 and the investigation was suspended until 1948. It was then found that susceptible crops had not been grown for some years in the garden from which the contaminated soil had previously been obtained. When soil from this source was again employed in greenhouse experiments, the results obtained indicated that severe infection no longer occurred consistently. Accordingly, in 1949 work was commenced with artificially contaminated soil, two types, a clay soil and a sandy loam, being employed in each experiment. The amount of spore suspension added to the soil was sufficient to provide a known level of spore load calculated on the basis of oven-dry soil, the range employed being 1,000–25,000,000 spores per gm. of soil. The *p*H value of the soils was adjusted from approximately *p*H 5·0 to approximately 7·5 by the addition of pure calcium hydroxide, calcium oxide or calcium carbonate. In such experiments it has been clearly demonstrated that the conditions provided by relatively high temperatures and high constant or fluctuating soil moisture content are most satisfactory for infection and development of the disease. It has also been shown that the highest numbers of infected plants in the alkaline soils are associated with the highest concentrations of spores. The results obtained suggest that

when plants are examined four to five weeks after having been transplanted into the contaminated soil, the presence of the largest root swellings is associated with the more favourable conditions for infection as indicated by the number of infected plants. During the progress of an experiment, the *p*H value of soil which had been adjusted to 7·5 by the use of calcium hydroxide or calcium oxide usually fell to about *p*H 7·0; the *p*H value of soil similarly adjusted by the use of calcium carbonate underwent less change.

In artificially contaminated soils treated with calcium hydroxide, infection was recorded in greenhouse experiments when the initial *p*H value of the soil was 7·8 in a sandy loam or 7·9 in a clay soil, falling to *p*H 7·1 and 7·2 respectively at the end of the experiment five weeks after transplanting the seedlings.

The results obtained in this investigation indicate that the efficacy of lime for controlling *P. brassicæ* will be determined by the interaction of such soil factors as temperature, moisture and spore load.

[July 13.

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THEORY AND PRACTICE OF ION EXCHANGE

A SYMPOSIUM on the "Theory and Practice of Ion Exchange" was held at Buckland House, Buckland, Berks, during September 24–25. The meeting was arranged at the invitation of the Physical Chemistry Group of the Atomic Energy Research Establishment, Harwell, and was organized by Dr. E. Glueckauf (Harwell), who in his opening remarks pointed out that it was primarily designed to enable workers in this field to compare results and to discuss the implications of recent work.

The first paper, from Dr. B. A. J. Lister (Harwell), was entitled "Applications of Ion Exchange in the Inorganic Field". After reviewing the progress in recent years in the use of synthetic ion exchangers in separation processes, he discussed some of his recent investigations (with Miss L. A. McDonald) by ion exchange methods into the solution chemistry of zirconium and hafnium. Dr. Lister described methods of determining the ionic charge and degree of the cation-anion complexing of the zirconium species in strong acid solutions. Diffusion measurements in resins of different cross-linkage were also used for assessing ionic diameters. In this way he was able to establish the presence of such species as $[Zr(OH)NO_3]^+$ and $[Zr(NO_3)_2]^{2+}$. The type of species present depended markedly on the anion and on the acid concentration of the solution.

Dr. J. D. H. Strickland (Chemical Inspectorate, Woolwich) illustrated a novel use of an anion exchange resin to determine the ionic charge on trace amounts of an anionic complex of nickel in alkaline solution. By plotting the logarithm of a function of the amount absorbed against the concentration of hydroxyl ions in solution, a straight line of slope equal to the ionic charge is obtained, when the concentration of the complexed species in the exchanger and in solution is small by comparison with the concentration of alkali. He also outlined work in progress to find ion exchange constants and citrate complexing constants at various temperatures for individual rare-earth and other trivalent cations.

Dr. S. M. Partridge (Low Temperature Research Station, Cambridge) contributed a paper on "The Use of Ion Exchangers in Organic Chemistry", in which he described both the displacement and elution techniques as applied to amino-acids and proteins. After illustrating typical applications of these techniques for separating simple amino-acids, he went on to discuss how far it is possible to use the method for the separation of proteins. It is remarkable that, as Stein and Moore have shown, the rate of equilibration of protein with ion exchangers seems to be very little slower, if at all, than the rate for amino-acids, although only a fraction of the total capacity is utilized. Presumably this is because, unlike the free amino-acids, proteins do not travel far into the exchanger before they become bound to it.

In the discussion on the foregoing papers, Prof. C. W. Davies (University College of Wales, Aberystwyth) described the separation of organic acids from grass extract by anionic exchange. Dr. J. F. Duncan (Harwell) pointed out theoretical objections to the use of ion exchange for determining ionic activity coefficients in solutions and the limitations which might be expected in the method. Dr. G. Waind (Harwell) supported the argument by describing results obtained with trace amounts of cobalt nitrate when equilibrated with a lithium-saturated exchanger in the presence of different concentrations of lithium nitrate.

Next came two contributions from the Chemical Research Laboratory, Teddington. In the first paper D. K. Hale discussed the properties desirable in an exchanger and described how different types of exchangers may be prepared and characterized. Measurement of swelling of the co-polymer, for example, can be used as a measure of the degree of cross-linking, and simple relations were reported between the swelling of unsulphonated resins of different cross-linkage in toluene and the swelling in water after sulphonation. Although one can use such tests to establish that two exchangers possess similar overall 'porosities', there is no direct evidence about how the cross-linking agent (for example, divinyl benzene) distributes itself throughout the resin. The capacity of a simple sulphonated polystyrene appears to be limited to one SO_3H group per benzene ring. The other paper, by D. Reichenberg, described some careful experiments to determine the water and acid uptake of exchangers with a content of 2–25 per cent divinyl benzene when immersed in solutions of hydrochloric acid. His experiments have established beyond doubt that the water in the exchanger is, within experimental error, identical in density with what it would be outside the exchanger. He showed that there is a linear relation between the weight of water taken up and the volume of swollen exchanger in water over a wide range of cross-linking, extrapolating to a value slightly less than the specific volume of the dry resin. The significance of change in cross-linking on the distribution of ions in the potassium/hydrogen, sodium/hydrogen

and sodium/potassium exchange systems was illustrated, and some remarks were made on the observed slower exchange-rates of exchangers of higher cross-linking.

Prof. Davies spoke next on "Electrochemical Behaviour and Applications of Ion Exchangers" under three heads. First, he mentioned the potentiometric measurement of cation activities by concentration cells. Second, he reviewed the work of Heymann and O'Donnell as an example of how the conductivity of ion exchangers might be measured by an A.C. technique and pointed out the disadvantages of their technique. Some of the work in progress in Prof. Davies's laboratory at Aberystwyth on the determination of the conductivity of hydrogen- and potassium-saturated exchangers at concentrations up to 1 *M* which seem to show some anomalies was also mentioned. Lastly he discussed the possibilities of separating ions by ionophoresis and electrodialysis under the influence of direct current. In the discussion, contributions were made by Dr. G. C. Barker and H. Small on precision measurements of resin conductivities in progress at the Atomic Energy Research Establishment, Harwell, showing that, when a hydrogen resin is gradually changed to a sodium resin, the conductivity is not linear with change in composition. Dr. Barker also reported some frictional effects observed with exchangers saturated with different cations. Dr. T. R. E. Kressman (Permutit Co., Ltd.) reported his observations in using membranes of a cation-exchange resin of the sulphonated phenol–formaldehyde type in concentration cells. He said that provided pure solutions were used and the concentrations lay between certain limits, the potentials obtained when the membrane separates two solutions of the same salt at different concentrations are reproducible and are those predicted by the Nernst equation, $E = (RT/F)\log a_1/a_2$. The activity functions which give the best agreement with this equation were the mean activities of cation and anion and not the single ion activities. When mixtures of salts were used, the potentials were generally complex functions of the activities of the individual salts. When the membranes separated pure solutions of salts having a common cation and different anions, the potential was that predicted by the Nernst equation plus a constant determined by the nature of the anions. Results were given for salts having sodium, potassium, ammonium and hydrogen as the positive ion, and it was shown that the limits between which they fitted the Nernst equation were wider the higher the ratio of the mobilities of the cation and anion in the membrane. With potassium chloride the *p*K limits were approximately 1 and 3, while with sulphuric acid the *p*H limits were $-0{\cdot}2$ and 4. Dr. Glueckauf pointed out that, while such measurements are very successful in the case of cations of high activity coefficients, they are bound to fail in the cases of potential measurements with 'resinates' of low activity coefficients. He produced data showing the extremely high nitrate uptake of silver 'resinates' which would adversely affect the transport number.

Dr. J. A. Kitchener (Imperial College of Science and Technology, London) completed the programme of the first day with a paper on "The Kinetics of Ion Exchange". In a general review, he discussed in particular the implications of the divergences which seem to be obtained near zero time when a film diffusion mechanism is fitted to the $\sqrt{t}$ law, and pointed out that such divergences seem to be very frequently obtained. The desirability of further theoretical study was stressed in the general discussion which followed. Dr. R. F. Hudson (Queen Mary College, London) remarked on the difficulties of obtaining an adequate mathematical treatment for a mixed particle-film diffusion mechanism, and Dr. A. Wasserman (University College, London) mentioned several interesting aspects of the kinetics and equilibrium of ion exchange in alginates.

The following day was devoted almost entirely to theoretical aspects of ion exchange. The opening paper, by Dr. Duncan, surveyed the existing theories of ion exchange and related subjects. He first considered what experimental data are necessary for an adequate understanding of the theory. He pointed out that the effect of the anion on the separation factor of two cations, which has frequently been observed, can be explained by taking account of the activity coefficients of the electrolytes in the aqueous solutions. In the case of heterovalent exchange these cannot be neglected even in solutions as dilute as $0{\cdot}02$ *M*. He then emphasized the close similarity of behaviour during recent years using highly cross-linked synthetic exchangers with that obtained using clays, bentonites, and synthetic and natural zeolites during the period 1900–25. This merits a careful re-assessment of the results obtained by the earlier authors using naturally occurring exchangers. The second half of Dr. Duncan's paper dealt with the theories put forward to explain the observed variation in mass product plot. The empirical approaches of Rothmund and Kornfeld, and also of Wiegner, have latterly been replaced by semi-empirical equations in which specific assumptions have been made for the activities of ions in the exchanger phase (for example, Vanselow, Boyd, Keilland, Gapon, Duncan and Lister). All these are limited to a greater or lesser extent in their range of applicability. The statistical approach of Overstreet was given special discussion, as was the treatment put forward by Gregor.

In the ensuing discussion, Dr. Kressman explained observations concerning the apparent non-equivalence of exchange when magnesium ions are used, which is due, he believed, to the formation of $MgOH^+$ or $MgCl^+$ species; Dr. Wasserman discussed the method used by him for drying alginate fibres without removing absorbed water; Mr. Hale referred to his experiments with large organic ions in which the distribution constant varied by several powers of ten; and J. K. Perring (Harwell) discussed a possible improvement on the Overstreet equation.

In the final paper of the session Dr. Glueckauf reported on the latest developments in the theory of cation exchange. He said that only if an ion exchanger is regarded unreservedly as an aqueous electrolyte (for example, sodium 'resinate') dissolved in the swelling water which the exchanger absorbs can properties such as osmotic and activity coefficients be unambiguously determined. He showed that the water contents of resins at known water activities (determined isopiestically by G. P. Kitt (Harwell)) permit the calculation of the osmotic coefficients $\nu\varphi = (\ln a_w)/0{\cdot}018\ \bar{m}$; and the trend of these curves indicates that ν, the number of freely mobile ions, is unity, which means that the fixed anionic groups of the exchanger do not contribute to the ideal statistical entropy terms of the free energy. By comparing the water-vapour pressures (a_w and $\bar{a}_w$, respectively) of two exchangers at the same concentration (in moles/1,000 gm. swelling water), one of high cross-linking and

the other of effectively zero cross-linking, it is possible to calculate the swelling pressure P of the highly cross-linked resins from the thermodynamically derived equation $\ln a_w/a_w = 0{\cdot}018\ P/RT$. Within the experimental error, this pressure was found to be a linear function of the resin extension (Hooke's law). It was shown that one is justified in the case of the resinates of hydrogen, lithium, sodium and potassium (though not of silver) in using the Harned rules for activity coefficients of mixtures, and that the knowledge of $\nu\varphi$ for different resinates permits of a good estimate of the ratio of the activity coefficients of these resinates. This, and the knowledge of P, permits the prediction of separation factors under varying conditions of the external solution and of the internal resin structure as modified by differences of cross-linking. These predictions have largely been confirmed by experiment. Dr. Glueckauf also showed that the amount of electrolyte taken up and the water lost by a cation exchange resin when in contact with a solution containing the same cation can serve to determine the absolute value of the thermodynamic activity of the resinate. He demonstrated from experimental data of Pepper and Reichenberg, and of Prof. Davies, that for hydrochloric acid which is in contact with sulphonated polystyrenes of different cross-linking there is a surprisingly high dissociation of the hydrogen resinate at 20 M concentrations, comparable with that of perchloric acid.

Replying to Dr. Wasserman, Dr. Glueckauf said that the implications are that the cations in the wet exchanger are in a state of mobility somewhere between that of nitrates and chlorides of similar ionic strength. He also pointed out that an increase in experimental accuracy would be required to draw further theoretical conclusions concerning the interaction of ions in the resin phase. In the discussion, Dr. Duncan quoted similarly calculated values for 'Dowex-50' in the presence of sodium iodide, sodium bromide and silver nitrate, which, within the limits of error, confirm the conclusions derived from the more sensitive data at lower cross-linking.

The final session was entirely a discussion period. Dr. Hudson gave an interesting account of the significance of ion exchange phenomena in the behaviour of wool, one of the most ancient ion exchangers. He showed that, in some cases, acid absorption by wool does not follow that to be expected on a simple particle-diffusion mechanism, although assuming a linear adsorption isotherm for the unadsorbed acid in the wool, the concentration of which is calculated by the Donnan membrane concept, theory and experiment can be brought into line.

Dr. K. W. Pepper (Chemical Research Laboratory, Teddington) described recent applications of ion techniques in the United States, including the separation of sugars on strongly basic resins using sugar-borate anionic complexes, the separation of nucleic acid degradation products, and the absorption of complex metallic anions from concentrated hydrochloric acid solutions on strongly basic resins.

Prof. Davies summed up the results of the conference, which, he said, greatly stimulated further research activities not only on account of the mass of new experimental facts but also by the new interpretation, which though not explaining every detail unified a large number of data on the behaviour of ion exchangers. He also reminded the conference of the confusion arising from individual symbolism, and said that the scientific societies of Great Britain have agreed to use square brackets [ ] for concentration units, { } for activities, γ for stoichiometric activity coefficients, and f for activity coefficients on a molar concentration scale; he supported the use of 'bars' for properties connected with the resin phase, as opposed to the external aqueous phase.

J. F. Duncan

BRITISH GELATINE AND GLUE RESEARCH ASSOCIATION

OPENING OF THE LABORATORIES

On November 29, 1951, the laboratories of the British Gelatine and Glue Research Association, at 2*a* Dalmeny Avenue, Holloway, London, N.7, were opened by Sir Roger Duncalfe, chairman of British Glues and Chemicals, Ltd. The opening ceremony was preceded by a reception and luncheon at Beales Restaurant, Holloway. In proposing the toast of the Association, Sir Roger referred to the state of the industry in the early days of the century, when he had just joined a glue works and was studying in his spare time with Prof. Kipping and his colleagues Drs. Sudborough, Lander, Caven and Sand. Scientific control was almost unknown, and the industry was faced with heavy competition. Before the First World War the first steps towards the use of science, towards greater technical efficiency and towards co-operation in the industry had been taken, so that the War found the industry prepared to meet the heavier burden imposed on it. The extension and strengthening of the manufacturers' federations, the introduction of standard methods of test, and the expansion of production resulting from technical progress in the period 1919–39, enabled the whole of the requirements of the industries to be met during the Second World War. In the post-war years the aim of the industry has been to achieve a credit balance of trade, thereby reversing the pre-1939 position. This has in large measure been done.

Sir Roger then referred to the decision to concentrate the main effort of the Association in its early years on fundamental research, to prepare the industry scientifically for difficulties which may come, and to maintain the rate of progress. He emphasized the importance of wide contacts in order to make use of work in other laboratories. In conclusion, he showed the connexion of the work of the Association to the study of living matter.

Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, supported Sir Roger's remarks. In his speech he directed attention to the very great gap which exists between carrying out scientific research and the exploitation of that research by industry. The application of research to industry does not occur automatically, but requires most careful consideration from both the scientific and the economic angles. While intelligible writing of reports assists in securing appreciation of the value of work in the industry, there must be sufficient scientific staff actually employed by firms to take full advantage of the research. The problem of developing the results of research beyond the laboratory stage is also one of very great importance.

Prof. F. J. W. Roughton, professor of colloid science in the University of Cambridge, also spoke in support of Sir Roger Duncalfe. He underlined the very

significant part which gelatine and glue have played in the history of colloid science, even to the extent of contributing the name from κόλλα, glue. The peak period for the academic study of gelatine as the typical hydrophilic colloid was during 1920–30, following the classical work in Great Britain of Procter and Wilson, and in the United States of Jacques Loeb. Interest has since been transferred to other proteins. There is a possibility that an intensive study of gelatin might throw new light on structural proteins, and also on their relation to globular proteins and hence on the entire field of protein chemistry and physiology. Prof. Roughton also emphasized the need for industry and the universities to take an interest in each other's work, and the important function a research association can discharge in acting as a link.

Mr. G. W. Odey, president of the Association, in replying to the toast, emphasized the dual need to be prepared to meet all demands on the industry in time of war, and to make a contribution in time of peace to the problem of balance of payments. He stressed the way in which the interplay of minds and of ideas has furthered scientific progress, although it is often difficult to trace the antecedents of any one discovery. The wide variety of industries which are users of gelatine and glue gives the industry an importance out of proportion to its size, and the research done will be of assistance over a wide field. He announced a donation of £1,000 to the Association from British Glues and Chemicals, Ltd., to mark the opening of the laboratories, and expressed his confidence in the future development of the work.

Mr. S. G. Hudson, chairman of the Association, directed attention to the very great assistance rendered to the Association by the Department of Scientific and Industrial Research and its stations, by other research associations, and by many other research workers.

The laboratories were inspected by those present and on the following day, November 30, were opened to visitors. The exhibits were designed to illustrate the scientific work carried out since the first staff were recruited just over two years ago. In addition, there was a display of the production methods of the industry, divided into the two parts, gelatine manufacture and bone glue manufacture, which included photographs of all stages of the processes, as well as examples of the materials at these stages.

The use of mixed bed ion-exchange columns for removing ionizable impurities from gelatine or glue was shown, together with an application of the method to the determination of isoelectric point. The significance of isoelectric opalescence of gelatin gels was also shown. A modified paper-chromatographic technique for amino-acids was illustrated with actual chromatograms. Analytical methods included colorimetric procedures for copper, iron and phosphate in gelatine and phosphate in bone meal. The application of Sanger's end-group technique to gelatin was demonstrated, the separation of the coloured amino-acid derivatives being clearly visible on the 'Celite' chromatographic columns. The isolation and properties of a mucopolysaccharide from compact bone tissue showed the importance of the non-collagenous constituents. Methods were demonstrated for determination of colour and clarity in gelatin, and for studies of the viscosity of dilute solutions. The marked reduction in bacterial content of deionized gelatin, immediately after deionization, was illustrated by figures of the bacterial counts. Interest in the technical laboratory was primarily directed to the newly built apparatus for freeze-drying gelatin or glue. Many other items of equipment were on show, establishing the very well equipped condition of the Laboratories.

On November 28, 1951, the Research Panel of the Association met at Beales Restaurant. The meeting was well attended by the staff of member firms, of government departments, of research associations, etc. The first paper was entitled "The Conversion of Collagen to Gelatin and their Molecular Structures", and was given by Dr. W. M. Ames, of J. and G. Cox, Ltd. Dr. Ames described the work he has carried out over a period of years, on the scientific basis of the manufacture of gelatin from hide and sinew. This work showed the primary importance of the pre-treatment of the raw material, by alkali or acid, in determining not only the ease of production of gelatin, but also in deciding the properties which the product would have. Dr. Ames also put forward two theories of the structure of collagen and the mode of its conversion to gelatin. The latter part of Dr. Ames's lecture gave rise to a lively discussion, together with some criticism, in the light of the work of the Association and of Dr. J. H. Bowes, of the British Leather Manufacturers' Research Association.

The second paper was given by Dr. G. Stainsby, of the Association's staff, on "The Viscosity of Dilute Gelatin Solutions", which dealt with the work Dr. Stainsby has carried out since joining the Association. This aroused interest particularly from firms using gelatine.

This meeting of the research panel was followed by the annual general meeting of the Association. The chairman, Mr. Hudson, in commenting on the annual report, stressed the importance of expanding the membership, to enable full use to be made of the facilities of the Association. The director of research, Mr. A. G. Ward, described the research which was being carried out, and showed the relation between the various items of the programme and the main scientific problems of the industry. Mr. B. G. McLellan, of the Department of Scientific and Industrial Research, commended the ready interchange of views which took place at the meetings of the Association, and also expressed appreciation of the way in which Prof. Roughton and himself had been brought into the various activities. Mr. G. W. Odey was re-elected president of the Association, and the only change in the composition of the Council was the addition of Mr. C. F. C. Simeons.

INTERLINGUAL AND SCIENTIFIC DICTIONARIES

A SECOND revised edition of the report on interlingual scientific and technical dictionaries circulated in July 1949 has now been issued*. This reflects the development of ideas through discussion of the original report, and the revised edition is published in the hope of eliciting comment from a wider circle which may further help in formulating Unesco's policy in this matter.

Ideas on the production and distribution of special dictionaries are still fluid; but Dr. Holmstrom envisages three basic principles as important. The

* Report on Interlingual Scientific and Technical Dictionaries. By Dr. J. E. Holmstrom. Second edition, corrected. Pp. 36. (Paris: Unesco; London: H.M. Stationery Office, 1951.) 1s. 6d. net.

terminology appertaining to each subject should be a responsibility of the international scientific or technical organization cultivating that subject. The first step should be to distinguish and to register under serial numbers the actual concepts, regardless of what words may rightly or wrongly be associated with those concepts according to the usages of different languages. In each language certain expressions should be standardized in the sense of being officially recommended for denoting particular concepts, as distinguished by sketches if concrete or by verbal definitions if abstract. Dr. Holmstrom visualizes the international organization desiring a dictionary for its special subject as first adopting a list of the requisite terms, together with illustrative sketches or definitions or descriptive verbal contexts in any suitable basic language and numbering them for reference. The agreed and numbered definitions, but not the terms themselves, would then be translated into each of the other languages desired and would be sent to authoritative organizations in countries using those languages. These organizations would respond with lists of the terms in their respective languages which they recommended should be associated with the numbered definitions or illustrations, and the international organization would then publish a dictionary quoting the terms thus collected, with or without the definitions or illustrations.

Dr. Holmstrom also directs attention to the advantage gained if no term intended for inclusion in a dictionary need be copied more than once from the time it is first suggested to the time it appears in the published work.

The bibliography which accompanied the original report has now been published separately*. It now includes 1,044 references grouped under 224 subject heads in accordance with the Universal Decimal Classification numbers, and taken from forty-five languages. The bibliography is bilingual, in French and English, and is provided with a language index as well as with the customary author and subject indexes. Fifty further dictionaries are listed in a supplement.

* Bibliography of Interlingual Scientific and Technical Dictionaries. By Dr. J. E. Holmstrom. Second edition, with corrections and supplement. Pp. 232. (Paris: Unesco; London: H.M. Stationery Office, 1951.) 4s. net.

CONTEMPORARY PSYCHOLOGY IN THE SOVIET UNION

A PAPER by Ivan D. London, of Harvard University, on "Contemporary Psychology in the Soviet Union"*, discusses the present-day general policy towards the subject which the Soviet Government is forcing its psychologists to adopt; the paper cites 104 references with full titles and dates of publication. It appears that the genetics controversy of 1948 in the U.S.S.R. was followed in 1950 by a similar controversy; but this time concerned with physiology and the allied subject of psychology, the alleged focal point being the work of Pavlov. Apparently, writers in the U.S.S.R. concerned with these two sciences have not shown sufficiently strong allegiance to the "materialistic foundations" of Pavlov. Although in the prefaces to their books Soviet physiologists and psychologists referred to the "materialistic foundations bequeathed to them by Pavlov", they proceeded to develop their sciences without much reference to his theories. Trouble resulted, and Rubinshtein, the only Soviet psychologist to date to develop a respectable general psychology on paper, had to confess to a "grievous sin" in that in his book of 685 pages, "Bases of General Psychology", he takes up questions connected with Pavlovian theory on only six pages. The American and English physiologists, Liddell and Sherrington, have been accused of showing evidence of "a bourgeois plot", and Sherrington and Pavlov personify respectively the forces of evil and good. Pavlov, who died in 1936, is represented as always an upholder of present-day Soviet theses and as being a posthumous supporter of Lysenko.

The consequence is that psychology in the U.S.S.R. has become an uninspiring discipline, more a matter of programme than of accomplishment, and even the work of out-and-out Pavlovians is little more than an unimaginative rehashing of past experiments. Some interesting experiments of Anokhim and his co-workers led to an attempt to escape from the limitations of the standard Pavlov technique, and he devised a general method which he calls the "method of active choice". In his view the role of reflexes as such is subordinated to that of "large-scale functional systems" (1949). He has, however, been condemned for his deviationism from the Pavlov theory.

In the field of sensation and perception, particularly that concerned with "sensory interaction", there is considerable Soviet work of apparent competence. Any non-visual stimulation that increases retinal sensitivity to green light has been found to decrease it to red light. Substances which heighten sympathetic excitability, such as adrenalin and ephedrine, increase retinal sensitivity to light in the green-blue region of the spectrum. Substances which heighten parasympathetic excitability, such as pilocarpine, increase sensitivity to light in the orange-red region (1950). Other interesting investigations are concerned with brain-function in its normal, pathological and restorative aspects.

Since 1936, educational psychology in the U.S.S.R. has been relegated in the main to the service of pedagogy. On the basis of an observational study of three gifted children, a psychologist notes that talent is accompanied by a remarkable inclination to work. The conclusion is drawn that "workers have an enormous advantage over the parasitic classes, and that in spite of the test-data of foreign scientists there is greater talent in the working classes".

There are a number of Soviet psychological journals; but the quality of the papers is extremely uneven, and the intrusion of political propaganda is a common feature. When in 1947 a second edition of Rubinshtein's "Bases of General Psychology" was published, although in 1942 it had been awarded the Stalin Prize, he was unreasonably attacked because it was said that he had neglected the psychology of the "new Soviet man", and had not correctly resolved the psycho-physical problem. The political and ideological strait-jacketing of psychology in the U.S.S.R. has been both restrictive and deleterious to its development; in contrast to the treatment of psychology, some branches of mathematics and of the physical sciences rival comparable work in other countries.

* Contemporary Psychology in the Soviet Union. By Ivan D. London. (Russian Research Centre, Harvard University, Cambridge, Massachusetts.) From *Science*, **114**, 227–233 (1951).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Malformations in Mouse Embryos induced by Trypan Blue

Gillman, Gilbert, Gillman and Spence in a recent paper[1] reported a series of malformations obtained in newborn rats as a result of injection of the dye trypan blue into female rats during varying stages of pregnancy. One of the interesting features of these malformations in rats is their remarkable resemblance to abnormalities known to occur in mice as effects of mutations[2,3].

A series of experiments was therefore undertaken to determine whether the trypan blue treatment might have a similar effect in the house mouse, and if so, whether developmental disturbances, like those found to be responsible for the genetically determined mouse abnormalities, were also involved in the malformations induced by the trypan blue dye.

Females of Bagg Albino mice, 80–88 generations inbred (kindly supplied by Dr. E. C. MacDowell), were injected twice with $\frac{1}{4}$–$\frac{1}{2}$ c.c. of a 0·5 per cent trypan blue solution, first at about eight days prior to fertilization, and then at seven to eight days after fertilization.

From twenty females injected, sixty-seven newborn mice were recovered, of which sixteen showed different types and degrees of tail abnormalities, resembling the well-known tail mutations of the mouse such as kink, brachy and fused[4]. Of the sixteen newborn mice with tail abnormalities, twelve were males and only four were females. The possibility that the treatment may affect the sex ratio is at present being investigated.

After it had thus been established that the trypan blue treatment was actually effective in inducing abnormalities in newborn mice, too, preliminary embryological examinations were performed. Twenty-seven Bagg Albino females were injected in the manner described above, and then killed 10, 11, 12, 13 and 14 days after fertilization, and their litters removed for gross examination and subsequent sectioning.

Eighteen of these mice yielded a total of 118 embryos, and observations on these embryos varying from 10–14 days in copulation age were as follows.

(1) Sixty-eight of the 118 embryos were abnormal.

(2) If the dye was injected between seven and eight days after fertilization, the majority of embryos showed two types of abnormalities : (*a*) abnormalities of the posterior axial region, such as kinky, short or curled tails ; in the 12-day embryos a constriction at various levels of the tail is visible, a condition resembling that leading to the shortening of the tail in the brachy mice[2] ; (*b*) abnormalities of the anterior axial region, for example, failure of the head folds to close, or an everted brain, sitting like a cap on top of the developing skull, resembling the mutation pseudencephaly[5]. The abnormalities of some embryos were so severe that they probably could not have survived to term. This would account, for example, for the absence of the pseudencephalic condition among the newborn mice and also for the fact that litter size was smaller at birth than at 10–14 days after fertilization. Furthermore, it would explain the higher incidence of abnormals among embryos (68 out of 118) than among the newborn (16 of 67).

(3) Both anterior and posterior types of abnormalities were visible at gross inspection as early as twelve days after fertilization, when growth and differentiation are most active.

The gross examination of embryos of female mice treated with trypan blue definitely shows that there exist similarities between the morphology of embryonic stages of malformations produced by trypan blue and of those genetically determined. A detailed histological examination of developmental systems, such as notochord, nervous system, etc., of the abnormal embryos will show how these are affected by the trypan blue treatment, and how their abnormalities compare with those described as effects of mutations in mice.

This study was begun at the suggestion of Dr. S. Gluecksohn-Waelsch, under whose guidance it is being carried out. It is being supported by a fellowship grant from the U.S. Public Health Service, Bethesda, Md.

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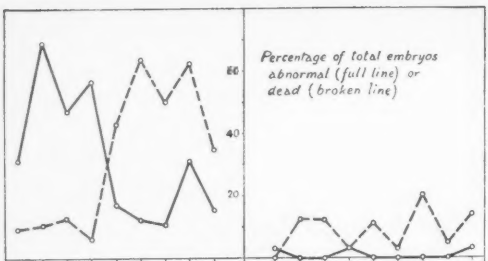
EXPERIMENTS in this laboratory, using inbred mice of the *CBA* strain, have given results similar to those described above by Hamburgh on the Bagg Albino strain. After some preliminary experiments, we used the following procedure. Males were placed with females overnight and the females were examined next morning for copulation plugs. Seven days after the plug, each experimental female was given a single subcutaneous injection of $\frac{1}{2}$ c.c. of 1 per cent aqueous trypan blue ; an equal number of females were kept as untreated controls. Embryos were dissected out 1, 2 . . . 9 days later, that is, at $8\frac{1}{2}$, $9\frac{1}{2}$ . . . $16\frac{1}{2}$ days embryonic age. Four females were used at each stage in each series ; females without implantations were discounted and replaced.

The accompanying graph shows the results. By twenty-four hours after injection there is already a raised incidence of abnormal live embryos ; this falls sharply at $12\frac{1}{2}$ days, when there is a compensating rise in the incidence of dead embryos. The abnormal live embryos are of a uniform type at each stage. At $8\frac{1}{2}$ days (presomite or early somite stage) the equatorial part of the egg cylinder (presumptive yolk-sac) is stained blue, in sharp contrast with the embryo proper ; the latter is often retarded and shows subectodermal blebs near the somites. At $9\frac{1}{2}$ days, when embryonic turning normally occurs, the blebs are still present dorsally ; the pericardium is also abnormally large and this apparently interferes with the turning process, so that the posterior part of the body fails to slip round the allantois and remains deflected along the right side of the anterior part. At $10\frac{1}{2}$ days these defects are still present : in addition the neural tube, which should by then have closed anteriorly, may still be open ; if closed, it is often convoluted in the thorax and the head is abnormally broad. By $11\frac{1}{2}$ days the deflected post-umbilical body is very small and retarded, the pericardium relatively enormous. By $12\frac{1}{2}$ days death intervenes.



TREATED
Total: 282 embryos

CONTROL
Total: 293 embryos

Between 12½ and 16½ days those embryos which successfully completed the turning process may develop hæmatomata on the head or, more often, the tail, or both. The commonest sites on the head are at the base of the nose and below the ear; on the tail, near the tip. A tail hæmatoma apparently interferes with development of the distal part of the tail; of the 58 live treated embryos aged 13½ days or more, seventeen had short tails (with or without head hæmatomata), three had head hæmatomata alone and one was otocephalic. Of 293 control embryos of all ages, 264 were normal, 26 dead, two moribund and one was unilaterally microphthalmic.

In a second series of experiments litters were carried to term. Experimental litters were small (and often cannibalized); they included many young with tail defects, some with head hæmatomata and a few which developed corneal opacity. The last, however, has been seen in untreated related stocks. A striking feature was a great deficiency of females in the experimental litters, among both normal and abnormal young (see table). Of 186 classified control young, 183 were normal, two had head hæmatomata and one clubfoot.

LITTERS CARRIED TO TERM
(*A* = abnormal, *N* = normal, ? = partly cannibalized)

Series	Females with plugs	Litters of zero	Progeny examined ♀ *N*	♀ *A*	♀ ?	♂ *N*	♂ *A*	♂ ?	?	Total	Mean litter size
Treated	31	8	10	4	1	26	13	10	7	71	2·29
Control	43	9	84	1	1	99	2	1	7	195	4·53

Our results are in agreement with those of Hamburgh, despite differences of procedure, notably (*a*) use of *CBA* instead of Bagg Albino mice, (*b*) absence of precoital injection, (*c*) higher postcoital dosage. The sex ratio disturbance, also noted by Hamburgh, is apparently due to differential mortality in the 11½-day embryos, and implies that significant differences between the sexes in their reactions to trypan blue are already established in the 9½-day embryo, before turning occurs.

Results with trypan blue are in sharp contrast with those obtained by L. B. Russell[1], who exposed pregnant mice to X-rays. Irradiation between 7½ and 9½ days caused a wide range of abnormalities, besides tail defects and cranial blisters, such as vaulted cranium, microphthalmia, coloboma, open eyelids, narrow snout, imperforate anus, hypospadias and other urogenital anomalies, overgrowth of the limbs and feet. None of these defects was seen in our treated mice (the sole case of microphthalmia being in a control).

We are indebted to Messrs. Imperial Chemical Industries (Dyestuffs Division), Ltd., for a sample of purified trypan blue; the work was carried out under a research grant from the Medical Research Council.

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Antigenic Properties of Growth Hormone and Adrenocorticotropic Hormone

THE antigenic properties of both purified growth hormone and adrenocorticotropic hormone (ACTH) have been the subject of relatively few investigations. Using growth hormone, Elberg and Li[1] have concluded that this hormone is non-antigenic. With adrenocorticotropic hormone both Gordon[2] and Chase[3], using different techniques, have concluded that antibodies are formed to this preparation. In this laboratory, preliminary immunizations led us to suspect the formation of antibodies to growth hormone and, as a consequence, we have reinvestigated the problem.

Sera were collected from the blood of rabbits which had received a series of injections of crystalline growth hormone and adrenocorticotropic hormone. Growth hormone was prepared from the anterior lobes of beef pituitary glands after the method of Wilhelmi, Fishman and Russell[4]; adrenocorticotropic hormone was prepared from hog pituitary glands as described by Fishman[5]. Both preparations were physiologically active and electrophoretically homogeneous. Titration of sera obtained after five injections (at 5-day intervals) in some cases indicated the presence of antibodies, and injections were continued over a period of nine weeks, at which time thirteen injections totalling 42 mgm. had been given. Blood was then collected and the sera stored at 0° in the presence of 0·1 per cent phenol.

Results with adrenocorticotropic hormone. The serum from rabbits injected with adrenocorticotropic hormone did not show precipitable antibodies when titrated against the hormone and crude hog pituitary extract. Two preparations of adrenocorticotropic hormone were used for these titrations, one prepared by us and another for which we are indebted to Messrs. Armour and Company of Chicago. It was therefore concluded that not only is adrenocorticotropic hormone non-antigenic under the conditions of our test, but also that our preparation is not contaminated by any antigenic protein.

Growth hormone results. Initially, the serum was titrated against the antigen (growth hormone—Australian National University), and positive precipitation tests (*A*, see table) indicated the presence of antibodies. It is also of interest to note that an identical result was obtained using another preparation of growth hormone, for which we are indebted

PRECIPITIN TITRES OF A GROWTH HORMONE ANTISERUM

A, Unabsorbed serum; *B*, after absorption with beef tissue extract; *C*, after absorption with beef tissue extract followed by absorption with Australian National University growth hormone

Test antigens	*A*				*B*				*C*			
	Serum dilutions (in 4 per cent horse albumin)											
	N	½	¼	⅛	*N*	½	¼	⅛	*N*	½	¼	⅛
Beef tissue extract	+++	++	+	−	−	−	−	−	−	−	−	−
Beef anterior pituitary extract	++	−	−	−	++	+	−	−	−	−	−	−
Growth hormone (Austral. Nat. Univ.)	+++	++	+	−	+++	++	+	−	−	−	−	−
Growth hormone (Wilhelmi)	+++	++	−	−	+++	++	−	−	−	−	−	−

to Dr. A. E. Wilhelmi, of Emory University, Georgia, U.S.A.

Positive precipitation reactions (*A*, see table) were obtained when the serum was titrated against a beef tissue extract prepared from skeletal muscle, adrenal and brain, indicating that the titre against the growth hormone could be due to the presence of contaminating proteins in the growth hormone preparation. The serum was therefore absorbed with the tissue extract to remove those antibodies specific to the proteins contained in the beef tissue. Titration of the absorbed serum against the same test antigens (*B*, see table) shows that the two growth hormone preparations still give the same titres.

The positive result obtained when a crude anterior pituitary extract was used as the test antigen is to be expected and is almost certainly due to the presence of growth hormone in the crude extract.

It is thus clear that antibodies specific to each of the two purified growth hormone preparations are present in the sera. Additional confirmation is given from the results of cross-absorption tests (*C*) carried out on the same sera. A similar result to (*C*) was obtained when the serum was absorbed with Dr. Wilhelmi's growth hormone following absorption with ox tissue extract. It may thus be said that the antibodies are serologically identical so far as the two antigens (Australian National University and Wilhelmi) are concerned. In view of the fact that our antigen was prepared by the method described by Wilhelmi, Fishman and Russell[4] and that the Wilhelmi antigen was prepared by Dr. Wilhelmi using a different procedure[6], it would seem unlikely that both preparations could be contaminated to the same degree by the same protein. While this possibility should be borne in mind it would, nevertheless, seem that crystalline growth hormone, as prepared, is antigenic. Some investigations designed to determine the species specificity of the growth hormone have also been carried out. The preliminary results indicate that the hormone is not species-specific.

The complete results of this work will be submitted for publication elsewhere.

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Enzymatic Formation of Glycerophosphorylcholine

THE isolation of glycerophosphorylcholine from incubated beef pancreas by Schmidt, Hershman and Thannhauser[1], and the availability of a method for the determination of this substance in tissue extracts[2] made it promising to attempt the isolation from pancreas of the phospholipases concerned. It was found that the phospholipases which split lecithin into glycerophosphorylcholine could be separated from their substrates and from enzymes causing further degradation of glycerophosphorylcholine by the following procedure.

An acetone powder of ox pancreas was extracted twice with cold ether and dried in a desiccator. The dry powder was kept in a refrigerator; 2 gm. of the powder was extracted for 10 min. with 15 ml. of a 50 per cent glycerol solution; 15 ml. of a 0·1 per cent sodium bicarbonate solution was then added and after an additional 15 min. the suspension was centrifuged at 12,000 r.p.m. for 10 min. The glycerol extract thus obtained kept its activity for weeks when stored in the cold.

Most of the phospholipase activity could be precipitated by diluting the glycerol extract with two volumes of water and bringing the solution to *p*H 5 with acetic acid. The precipitate was washed with *M*/100 acetate buffer at *p*H 5·0 and suspended in water (half the volume of the original glycerol extract).

Optimal conditions for the formation of glycerophosphorylcholine from lecithin have been established in the following test system.

1 ml. of the test mixture, containing 5 micromoles of the substrate, 50 micromoles of acetate buffer *p*H 4·5 and 0·5 ml. of the enzyme suspension, was incubated at 37° C. for 0 and 3 hr. The reaction was stopped by adding 4 ml. of 5 per cent trichloroacetic acid. The glycerophosphorylcholine content was determined in a 2-ml. aliquot by a modification of the method of Schmidt *et al.*[2], the choline determination being carried out by the iodide method of Roman[3], rather than by reineckate precipitation, and with the use of ammonia instead of sodium hydroxide for neutralization after acid hydrolysis of the diester. In addition, decrease in ester linkages was determined by a modified hydroxamic acid method[4], using the alcohol – ether extract of the reaction mixture instead of a suspension of the esters in water. The inclusion of the organic solvent in the reaction mixture permits of formation of the hydroxamic acids from higher fatty acid esters in the conditions of the assay. The accompanying table presents representative results.

The table shows that preparations from fresh acetone powders split lecithin into glycerophosphorylcholine, without any further degradation to free choline. Commercial lecithin is split much faster

Enzyme	Substrate	Increase in micromoles of Glycero-phosphoryl-choline	Free choline	Decrease in micro-equiv. of ester linkages
Precipitate at *p*H 5 from fresh acetone powder	pure egg lecithin	0·64	0·02	0·00
" "	commercial lecithin (Nutritional Biochemicals)	0·98	0·03	0·84
" "	lysolecithin (ref. 5)	1·43	0·04	1·35
Precipitate at *p*H 5 from acetone powders stored for 2 months	pure egg lecithin	0·08	0·02	0·00
	commercial lecithin	0·74	0·02	0·72
	lysolecithin	1·56	0·04	1·62

than is pure lecithin. This may be due to its lysolecithin content. Both lysolecithin and commercial lecithin are split by a different type of reaction than is pure lecithin, glycerophosphorylcholine formation being accompanied by an equivalent decrease in ester linkages. No decrease in ester linkages was found when lecithin is split. With aged powders, this difference becomes more and more marked, until the ability to split pure lecithin is completely lost.

The results can be explained by the assumption that two systems are involved: System 1 catalysing the reaction,

lysolecithin → glycerophosphorylcholine + fatty acid.

This system is active in the 'acid precipitates' of fresh and stored acetone powders, and is similar to the lecithinase *B* of Contardi and Ercoli[6]. It does not act on pure lecithin.

System 2 catalyses the reaction,

lecithin + acceptor → glycerophosphorylcholine + acceptor – fatty acid.

It is active in 'acid precipitates' of fresh acetone powders only, and is different from any of the lecithinases described. The fatty acids are transferred from lecithin to an unknown acceptor, forming a new linkage, which gives the hydroxamic acid reaction. The nature of this acceptor is not yet clear. However, it could be shown that the acceptor is contributed by the enzyme preparation, and its amount is a factor limiting the extent to which the reaction can proceed. Not more than 20 per cent of the lecithin could be split in our test mixtures even after prolonged incubation. Addition of boiled enzyme preparation causes the reaction to proceed further.

I am indebted to Dr. Gerhardt Schmidt, in whose laboratory part of this work was carried out, for his hospitality and interest.

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Utilization of Glutamine and Asparagine and their Peptides by Micro-organisms

Although the utilization of asparagine and glutamine by micro-organisms has been studied in recent years, nothing is known about the metabolism of their simple peptides. Aspartic acid can support optimal growth of *Leuconostoc mesenteroides*; but asparagine is utilized only to a small extent[1,2]. It has recently been found in this laboratory that the utilization of asparaginylglycine and glycylasparagine approximates that of the free dicarboxylic acid, and is better by far than that of asparagine[2]. The same was found to be true for *Lactobacillus arabinosus* under conditions of incubation that precluded the endogenous synthesis of aspartate (26° *in vacuo* over potassium hydroxide or 39°)[3]. On the other hand, glycylglutamine and glutaminylglycine replace glutamine molecule for molecule in the metabolism of *L. arabinosus*, and the organism grows in synthetic media containing the peptides or the free amide without the lag period characteristic of its growth in media containing glutamic acid. It has been shown previously that the sulphoxide derived from methionine competitively inhibits the utilization of glutamic acid, but has no effect on the utilization of glutamine[4]. In this respect, too, the glutamine peptides behave exactly as the free amide[2].

The following possibilities present themselves as an explanation for the more effective utilization of the asparagine peptides and aspartic acid as compared to that of asparagine: (*a*) asparagine peptides may be deamidated with greater ease than asparagine, and the resulting peptide split into the dicarboxylic acid and glycine by peptidases; (*b*) the peptides and aspartic acid may be taken up by the microbial cell at a more rapid rate than the free amide; (*c*) the asparagine peptides fulfil a need of this organism for naturally-occurring asparagine peptides, or meet the conditions under which the peptides themselves or the asparaginyl radical may most readily be utilized.

In an attempt to explore these possibilities, the deamidation of the peptides by chemical means was studied. Upon acid hydrolysis, the asparagine peptides, very surprisingly, proved to be more labile than the free amide. The finding that glycylglutamine is more stable than glutaminylglycine or glutamine was confirmed (see table, col. 3)[5].

When the glutamine or asparagine peptides were incubated with resting cells of *L. mesenteroides*, considerable liberation of ammonia occurred. No ammonia beyond the blank values was found in the case of the unsubstituted amides (see table, col. 1).

Ammonia Liberated (as per cent of Total Amide) from Asparagine, Glutamine and their Peptides by Incubation with *L. mesenteroides* and by Acid Hydrolysis

Compound	*L. mesenteroides* (1)	*L. mesenteroides* (2)	10 per cent Trichloroacetic acid (3)
Asparagine	0	14	8
Glycylasparagine	34	96	25
Asparaginylglycine	26	90	20
Glutamine	0	6	92
Glycylglutamine	12	85	37
Glutaminylglycine	39	76	98

(1) Resting cells (washed twice with saline) of *L. mesenteroides* (approx. 5 mgm. dry weight) incubated with 4 micromoles of compound in 4 ml. of *M*/15 phosphate buffer (*p*H 6·5), 35°, for 2 hr.
(2) Same as (1) with 5 mgm. of glucose added.
(3) Compounds in 10 per cent trichloroacetic acid for 1 hr. at 70°. Ammonia determined titrimetrically after aeration.

It has been found previously that resting cells of *Strep. hæmolyticus* (Richard's)[6] and *L. arabinosus*[7] are only able to liberate ammonia from glutamine when they are permitted to glycolyse. Therefore, the degradation of glutamine and asparagine and their peptides was studied with resting cells of *L. mesenteroides* in the presence of glucose. While some ammonia developed from the free amides under these conditions, practically all the amide nitrogen was liberated from the peptides, if it can be assumed that the ammonia evolved results from deamidation (see table, col. 2). Although the metabolic pathway of the compounds has not been established under these particular conditions, the results clearly indicate that the glutamine and asparagine peptides are metabolized at a much more rapid rate than the corresponding free amides by resting cells of *L. mesenteroides*, both in the presence and absence of glucose. Similar results for asparagine and its peptides were obtained with resting cells of *L. arabinosus*. The preferential degradation of the asparagine peptides when compared with that of asparagine is in accord with the previously observed differences in ability of these compounds to support the growth of *L. mesenteroides*[2].

The effect of differences in the rate of uptake of the peptides and the free amides by the cells on their metabolic degradation cannot be assessed at present. The enzyme systems of the micro-organisms studied may be better adapted for dealing with the peptides than with the free amide. The possibility should be considered that the effect of simultaneous glucose metabolism might consist in the transformation of the free amides and possibly the peptides themselves into intermediates (specific peptides ?) susceptible to rapid metabolic utilization. Considerable clarification of this problem may be expected from a study of the enzyme systems in cell-free extracts.

We are indebted to the Rockefeller Foundation and the National Vitamin Foundation for the support of this work.

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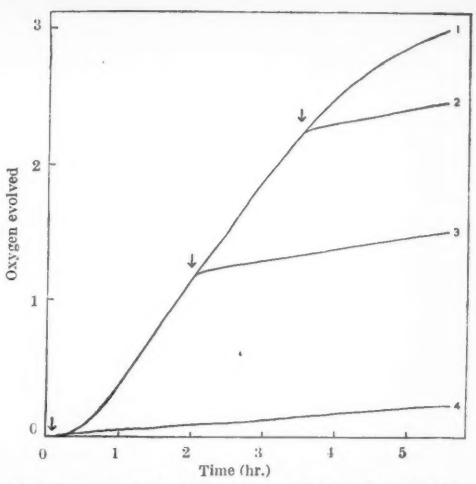
Inhibition of Adrenaline Oxidation by Borate

THE inhibition of adrenaline oxidation by reducing agents is well known and used for stabilizing adrenaline solutions. A different kind of inhibition was recorded by da Fonseca-Ribeiro and Cardoso[1], who observed that adrenaline solutions were stabilized by oxalic acid; they suggested that this effect was due to the formation of complexes between the acid and the copper and other metallic ions necessary to initiate the oxidation.



Effect of borate added at various stages of adrenaline oxidation. *M*/15 phosphate buffer, *p*H 8·7; temperature 37·5° C.; 100 shakings/min. Final adrenaline concentration *M*/500. (1) No borate; (2), (3), (4), borate buffer, *p*H 8·7, added at arrows. Final borate concentration *M*/50

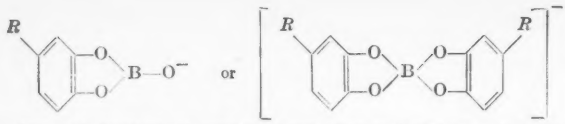
During investigations in which the oxidation of adrenaline was compared in various buffers, we found that an inhibition, again of a different kind, was effected by borate. The observation does not appear to have been previously recorded, and is considered of interest in so far as it may throw additional light on the toxic action of borate.

When dilute solutions of adrenaline, *M*/500–*M*/2.000, were allowed to oxidize in phosphate and borate buffers, it was found that the oxygen uptakes in the case of phosphate buffer increased rapidly as the *p*H was increased above 7·0. With borate buffer, however, the oxygen uptakes remained very low and almost unchanged up to a *p*H of just above 9·0. Above *p*H 9·5 the oxidation-rates increased markedly, though they were still lower than in other buffers at the same *p*H.

Adrenaline was allowed to oxidize in phosphate buffer in the presence of varying concentrations of borate. To produce inhibition, borate had to be present in concentrations much exceeding that required for catalysis; about 50 per cent inhibition was observed when adrenaline and borate were present in equimolar proportions, at *p*H 7·8, 37·5° C., the concentration of each being *M*/500.

When sufficient borate was added at various stages to adrenaline oxidizing in phosphate buffer, an almost immediate inhibition was observed (see graph). The degree of this inhibition appeared to be the same no matter whether the borate was added early or later to the oxidation mixture.

If it is accepted that adrenaline oxidation starts with the oxidation of the phenolic groups, its inhibition by borate is not surprising, since it is well known that boric acid forms complexes with polyhydroxy compounds. It may be assumed that compounds similar to borosalicylic acid, or to those described by Boeseken[2], and by Tzuzuki and Hayakawa[3] and others, are formed, and that the blocking of the hydroxyl groups hinders the onset of oxidation. Since the effect of added borate is almost unchanged even after the uptake of one to two molecules of oxygen per molecule of adrenaline originally present, it appears that borate forms complexes not only with



Suggested structure of complex formed between borate and adrenaline.
R = adrenaline side-chain

adrenaline but also with all *o*-diphenols formed during the oxidation sequence: leuco-adrenochrome, N-methyl-4 : 5-dihydroxy-indoxyl, and possibly others.

The adrenaline–borate complex appears to be present in equilibrium with its components, and to become unstable at *p*H levels above 9 (borax has a *p*H of 9·5) and on dilution. When adrenaline–borate mixtures, in molecular ratios 1 : 1 to 1 : 3, were injected intravenously into an anæsthetized cat, they showed neither an inhibition or intensification, nor a prolongation of the adrenaline effect on the blood pressure and the nictitating membrane. However, it is considered that by forming complexes with polyhydroxy compounds, borate, in sufficiently high concentrations, may prevent the normal metabolic reactions of these groupings; this may, at least in part, be responsible for the toxic effects of the drug. In a recently reported fatal case of borate poisoning (a newborn infant, treated with U.S.P. 10 per cent boric acid powder and ointment for excoriation of the buttocks[4]), the concentration of the acid in the tissues was found to be 0·052 per cent, which is almost 0·01 *M*, and thus higher than most of the borate concentrations used in our experiments.

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July 26.

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Occurrence of Cellulase in *Limnoria*

Since the report by Yonge[1] on the absence of cellulase in the marine wood-boring isopod *Limnoria*, the nutrition of this destructive organism has remained a perplexing problem. A re-examination of the question has resulted in findings different from those of Yonge, and, in view of the commercial and biological importance of the borer problem, publication of a preliminary note at this time seems warranted.

The species investigated is *Limnoria lignorum*. Specimens were taken from their burrows alive, and the entire bodies or selected tissues were used immediately. The material was ground at 4° C. in a glass tissue homogenizer capable of handling quantities as small as 0·1 ml. The homogenate was then transferred to McNaught graduated tubes, and a drop of very finely divided cellulose suspension, prepared from filter paper by Hungate's[2] method, was added. Control tubes were also included as indicated in the tabulated results. All tubes were kept at room temperature. Toluol was added to prevent bacterial or fungal growth during the experiment, and as an additional check the homogenate was inoculated into sterile plates and tubes using Stanier's[3] media and technique for the culture of cellulolytic micro-organisms. The presence of reducing substances, determined by the appearance of the typical brick-red precipitate after boiling with Benedict's reagent, was taken as evidence that the cellulose had been attacked. The tubes were tested for reducing materials at the beginning of the experiment and at the times indicated. Repeated series of tests, using tissues from a total of more than five hundred specimens, have in each instance given similar results.

Reaction mixture	0 hr.	18 hr.	48 hr.	5 days
Sea water alone (8)*	–	–	–	–
Cellulose suspension in sea water (5)	–	–	–	–
Sea water in which the dissections were carried out, with cellulose suspension (6)	–	–	–	–
Homogenate of entire body†, with cellulose suspension (1)	–	–	–	–
Homogenate of body minus diverticula, with cellulose suspension (1)	–	–	–	–
Homogenate of gut, minus the diverticula, with cellulose suspension (2)	–	–	∓ ?	∓ ?
Homogenate of diverticula ‡ in sea water alone (4)	–	–	–	–
Homogenate of diverticula, with cellulose suspension (8)	–	+	+	+
Homogenate of diverticula, placed in bath of boiling water for 15 min., with cellulose suspension (4)	–	–	–	–

+ Indicates a positive Benedict's test. In the cases of negative tests, the tubes were allowed to stand for as long as eleven days: but repeated tests with Benedict's solution failed entirely to give evidence of reducing substances.
* Numbers in parentheses indicate the number of times the experiment was repeated.
† Bodies of 50 specimens, homogenized in 0·3 ml. sea water.
‡ In preparing the diverticular homogenate, in all cases tissue from at least ten animals was ground in 0·1 ml. sea water.

From the accompanying table of results, it appears likely that an enzyme capable of catalysing the hydrolysis of cellulose is present in the enteric diverticula of *Limnoria*. The negative results of the previous investigation[1] have been fully confirmed. The absence of detectable reducing substances under those experimental conditions may have been due to too low a concentration of the enzyme, to the possible interference of other materials which might act as enzyme inhibitors, or to other tissues using up sugars as fast as they might be formed. Whatever the correct explanation, positive and consistent evidence of the formation of reducing substances is obtained only when the diverticular tissue alone is allowed to act on cellulose.

No evidence was obtained that the appearance of reducing materials in the tubes containing diverticular homogenate was due to the action of micro-organisms. Repeated microscopic examination of the homogenates and of *Limnoria*, both freshly dissected and in fixed and stained serial sections, has failed to disclose the presence of symbiotic microflora. In addition to using toluol in the reaction tubes, all efforts to culture cellulolytic micro-organisms from the homogenates were without success. The conclusion, therefore, that the cells of the enteric diverticula of *Limnoria* produce cellulase appears justified.

While the demonstration of the presence of cellulase does not necessarily imply that *Limnoria* depends largely or even in part on the decomposition of cellulose to supply simple carbohydrates for the synthesis of cell material or for energy, it does warrant further investigation of this possibility. Experiments

designed to characterize the enzyme and to identify the reducing material, and quantitative measures of the amount of cellulose hydrolysed, are proceeding.

This work forms part of an investigation on the physiology of *Limnoria*, supported by funds of Initiative 171 of the State of Washington.

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Caffeine in Cacao Beans

It is stated by Knapp[1] in his standard text-book on "Cacao Fermentation" that caffeine, the minor alkaloid of cocoa, occurs in fresh cacao beans as an L-epicatechin–caffeine complex. This statement would appear to be based on the work of Ultée and Van Dorssen[2], who isolated such a complex from aqueous extracts of beans, and on the mainly unpublished work of Adam[3,4], who showed that simple mixing of aqueous solutions of the two substances produced the sparingly soluble complex.

However, by molecular weight determinations, Ultée and Van Dorssen[2] showed that the complex was completely dissociated in aqueous solution. We attempted to find whether the caffeine was present in the fresh bean in a free or combined form by paper chromatography of various extracts with a variety of developers. In every case caffeine was found only in the free form on the paper. It was detected by its absorption of ultra-violet light[5].

Synthetic preparations of the complex were made by simply mixing aqueous solutions of the two components. A precipitate was obtained over a wide range of concentrations and crystallized from methanol as short prisms of melting point 83° (uncorr.). The anhydrous preparation was found by analysis to be a 1 : 1 addition compound of caffeine and L-epicatechin[2,4]. However, when such a preparation was chromatographed on a paper strip against an aqueous stationary phase, the two components were separated and had their usual R_F values even in neutral solvents. They also separate on chromatography in water alone. Further, the caffeine could be completely extracted from an aqueous suspension of the material by cold chloroform.

A discussion of whether caffeine exists in the cacao bean free or as a dissociated complex would appear fruitless. The isolation of such an easily formed material as the L-epicatechin–caffeine complex is most certainly not proof that it exists as such in the bean.

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July 25.

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Acid-soluble Lignin

In a communication[1] prepared and accepted for presentation at the Twelfth International Congress of Pure and Applied Chemistry (New York, Sept. 1951), it is shown that, in the course of the delignification of wood by sodium chlorite buffered at *p*H 6·3, there is formed and retained in the wood residue (holocellulose) a modification of lignin which is not determined as a solid residue by the 72 per cent sulphuric acid method. The form of lignin is soluble in sulphuric acid. The possible existence of a soluble form of lignin in the acid hydrolysates of woods has been recognized for many years but, until recently, few attempts have been made to isolate it. Von Wacek and Schroth[2,3] have emphasized the difficulties involved in such an isolation in view of the presence in wood hydrolysates of acids and sugars in addition to lignin. They show, however, that a substance of high methoxyl content (presumably lignin) can be extracted from spruce holocellulose by means of 24 per cent aqueous potassium hydroxide. This alkaline extract also contains hemicellulose. A somewhat elaborate procedure is outlined whereby the alkaline liquor remaining after removal of the hemicelluloses can be treated with acid and alcohol in such a way as to cause precipitation of the substance of high methoxyl content.

In work which has been contemporaneous with that of von Wacek and Schroth, a simple method has been evolved in this Laboratory for the isolation of soluble lignin from acid hydrolysates of wood and holocelluloses, and also from the mother liquors of hemicellulose preparations from beech wood. This method involves the use of ion exchange resins, and will be described in detail at a later date. At this stage the relationship between the lignin isolated by us, on one hand, and either that isolated by von Wacek and Schroth[2] or the soluble lignin isolated by Stumpf and Freudenberg[4] from spruce and beech woods by means of cold, acidified dioxan and other solvents, on the other, is not known.

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Constituents of *Andrographis paniculata* Nees

In the little work that has been done hitherto on the constituents of *Andrographis paniculata* Nees (Acanthaceæ)[1] only Bhaduri[1c] has claimed to have isolated a second bitter constituent in addition to the amaroid andrographolide. From the way in which he isolated and purified both products, it may be concluded that he obtained neither in a pure state.

On re-investigation of the herb, which is highly valued by the Indonesian people as a medicine for a great variety of diseases, besides the intense bitter

andrographolide a second—non-bitter—constituent has now been isolated. Whereas amounts of andrographolide up to 5 per cent of the dry weight of the plant have been obtained, I never obtained more than 0·02 per cent of the other product, for which the name neoandrographolide is proposed.

From the analysis of neoandrographolide and its acetylation product, the empirical formula $C_{22}H_{38}O_8$ for the former is calculated; by Barger's method this formula proves to be the net formula also. The substance melts at 174°–174½° without decomposition, and has $[\alpha]_D^{25} = -39{\cdot}9° \pm 1{\cdot}2°$.

Neoandrographolide gives positive Legal, Tollens and Raymond reactions; the reactions with ammoniacal silver solution and ferric chloride are negative. When the substance is warmed in aqueous potassium hydroxide, it slowly goes into solution. On trying to liberate the parent acid from the potassium salt, neoandrographolide is regenerated. From these results it may be concluded that neoandrographolide is an α,β-unsaturated γ-lactone.

On hydrogenation with Adam's catalyst, neoandrographolide absorbs about 1½ moles of hydrogen. A similar anomaly has been observed with andrographolide, which absorbs about 2½ moles of hydrogen[2]. With andrographolide the absorption of more than two moles of hydrogen originates from another double bond formed during the hydrogenation process, when a tertiary hydroxyl group is partially split off as water and not from the opening of the lactone ring. As neoandrographolide also contains a tertiary hydroxyl group that is easily removed, its absorption of more than one mole of hydrogen may be due to the same cause. The Legal test with the perhydro products of neoandrographolide being no longer positive indicates that the double bond of the unsaturated lactone ring has been hydrogenated. So far, no satisfactory explanation of the partial elimination of the tertiary hydroxyl group can be given.

In accordance with the above scheme, anhydroneoandrographolide tetra-acetate, from which the tertiary hydroxyl group has been completely removed, takes up two moles of hydrogen on catalytic hydrogenation.

Acetylation with acetic anhydride – zinc chloride or with acetic anhydride – pyridine gives the same anhydrotetra-acetate $C_{23}H_{32}O_7(COCH_3)_4 = C_{31}H_{44}O_{11}$ (m.p. 157°). This suggests that five oxygen atoms are present as hydroxyl groups, one of which is tertiary. Two further oxygen atoms are arranged in the lactone ring; the eighth oxygen atom may be part of a heterocyclic ring, since the molecule shows no evidence of a carbonyl function, nor an ether-oxygen (Zeisel).

Neoandrographolide probably contains besides the lactone ring one isocyclic and one oxygen-containing heterocyclic ring. Owing to the fact that neoandrographolide has many properties in common with andrographolide the carbon skeleton of both substances may be largely identical.

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Interaction of Travelling Magnetic Fields with Ionized Gases

The magnetic field associated with an electromagnetic wave propagated along a conducting helix has been used for accelerating electrons in the direction of propagation of the wave.

When an ionized gas is confined in a toroidal vacuum vessel and the wave is propagated in the direction of the circular axis of the torus, direct current of tens of amperes is readily produced.

Initial experiments were carried out in a straight glass tube 5 cm. in diameter and 60 cm. long containing mercury vapour at about 10^{-3} mm. mercury pressure. A helix of close-wound copper wire was loaded at intervals with condensers to reduce the velocity of wave propagation to 6×10^7 cm./sec. This transmission line was either short-circuited or terminated in its characteristic impedance. The input end of the line was fed from a 1-megacycle oscillator capable of delivering 3–4 kW. of radio-frequency power.

When the current in the helix was sufficient to establish an electrodeless ring discharge in the vapour, two probes at opposite ends of the helix indicated a constant potential difference of 4–5 volts. This potential difference increased with radio-frequency power input. The luminosity extended a greater distance away from the short-circuited end of the line than from the input end.

A transmission line with similar characteristics was arranged around a glass torus of 18 cm. mean diameter and 4 cm. tube diameter as shown in Fig. 1. The 0·0011-μfd. condensers were spaced every twelve turns of the helix. The circulating direct current was measured by a compass and compensating coil. Fig. 2 shows the direct current obtained for various radio-frequency input currents to the line in the case of xenon gas at 10^{-3} mm. of mercury.

The standing-wave ratio in the line in the presence of the discharge was usually about 2 : 1 in the short-circuit case, and the voltage across the line decreased exponentially towards the short-circuit end. The magnitude of the direct current was not sensitive to either phase velocity or frequency but showed a wide change with gas pressure. Fig. 3 shows the type of variation with gas pressure.

The origin of the force driving electrons around the torus is readily understandable from a macroscopic point of view. In cylindrical co-ordinates, the

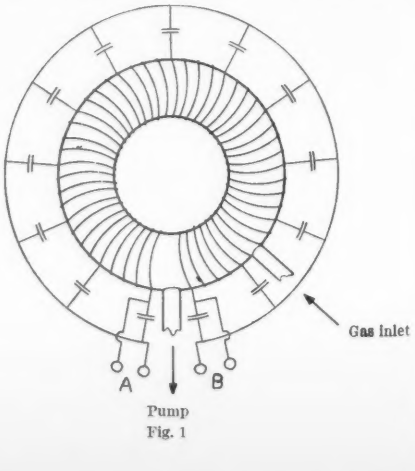

Fig. 1

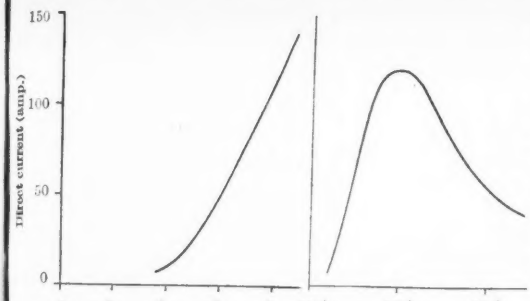

Fig. 2 Fig. 3

Xenon. Phase velocity, 6×10^7 cm. sec.$^{-1}$; frequency, 1·36 Mc./s.; line short-circuited

changing Z-component of the magnetic field induces electron currents circulating in the φ direction. These currents interact with the radial component of the magnetic field and therefore experience a force in the direction of wave propagation.

If the electron currents are in phase with the electric field, the force is always in the direction of propagation. If the electron currents are $\pi/2$ out of phase with E_φ, the net force over a cycle vanishes. In this case electrons are not accelerated unless trapping takes place and the phase velocity of the wave is increased (cf. linear accelerator). These two cases are analogous to the induction motor (no trapping) and the synchronous motor (full trapping).

It is interesting to note that radio-frequency power can be converted into direct current power without the use of a commutator or a non-linear circuit element.

Evidence has also been obtained for the amplification of a radio-frequency signal injected into a line which enclosed the plasma of a direct-current arc.

It may be possible to use this method to produce circulating currents in a superconducting ring. The mean velocity of the superconducting electrons would then be known, and thus the number of electrons taking part in the current flow.

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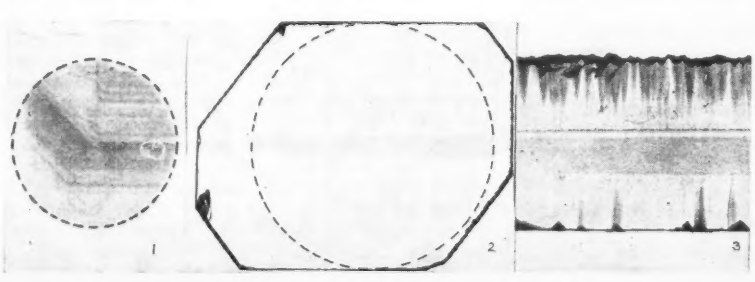
Response of Synthetic Quartz to X-Ray Irradiation

It is well known that natural quartz darkens when exposed to irradiation by X-rays, although the degree of darkening varies considerably from specimen to specimen. Moreover, within certain specimens, variations in the degree of darkening occur which are obviously related to crystallographic features. Frondel[1] has studied these effects and also reported a change in the elastic constants of quartz resulting from X-ray irradiation.

In the majority of the experiments reported here, we have employed white radiation from a Machlett X-ray tube having a tungsten target and operating at 35 kVp. and 15 mA. An adequate exposure time has been found to be 10 hr. when using a focus-to-specimen distance of 3 cm. Irradiation under these conditions produces uniform darkening in most specimens of natural quartz, but in some specimens an effect occurs which is typified by the X-ray darkening pattern reproduced in Fig. 1. The plate was cut at a small angle to the major rhombohedral plane $(10\bar{1}1)$ and the area irradiated limited by a circular aperture in a lead mask, which is shown on the figure by a broken circle. Bands of darkening of alternating intensity are clearly visible, and these are found to correspond to the intersection of the plane of the plate with successive layers of the primary rhombohedron. It is inferred that this effect is related to periodic variations in the conditions of growth of the parent quartz crystal.

In interpreting the behaviour of natural quartz when subjected to X-ray irradiation, experiments which we have carried out on synthetic crystals are of particular interest. Synthetic quartz grown by the temperature-gradient method[2], which is believed to be of high crystalline perfection, shows no darkening when exposed to X-rays even when the exposure is increased to 24 hr. This result is well illustrated by Fig. 2, which shows a section of a large synthetic crystal grown on to a thin seed plate of natural quartz. Only the central part of the section, corresponding to the natural seed, shows any darkening. Similar experiments have been conducted on synthetic crystals grown by a different method[3]. In these, although the crystalline quality appears to be good, there is evidence that imperfections do exist. When exposed to X-rays the resulting darkening is comparable with that obtained in an average natural crystal. However, the colour of the darkening is a distinct purple (similar to that of amethyst), in contrast to the smoky colour usually produced in natural quartz.

Employing the temperature-gradient method, synthetic quartz crystals have been grown in which various foreign ions such as copper, chromium, manganese and arsenic have been deliberately introduced. In particular, crystals have been grown containing sufficient copper to colour the crystal blue. When these copper-containing crystals are irradiated with X-rays, substantial darkening does occur, in contrast to the failure to darken of the crystal without additives. This is illustrated in Fig. 3, which shows a section which has been subjected to X-ray irradiation of a crystal containing copper. In this instance the darkening of the seed plate in the middle of the crystal is relatively uniform; but in



In Figs. 2 and 3, the seed plate of natural quartz shows as a horizontal band across the centre of the specimen

the new growth the darkening is irregular and appears to spread in columns from points in the early stages of the growth. It has been found that a different darkening pattern is produced with a synthetic crystal containing arsenic, and it would appear that the nature of the darkening is closely related to the manner of growth of the synthetic crystal and the way this is modified by the nature of the foreign ion.

It is concluded from the results with irradiated synthetic crystals that the darkening in natural quartz may be associated with the presence of impurities, and that changes occurring during the growth of a crystal often produce corresponding changes in the susceptibility to X-ray darkening in the different parts of the crystal. It is noteworthy that quartz grown under the best conditions in the laboratory, and which is probably of high purity, does not darken. However, when the synthetic quartz is grown in less perfect conditions as in the alternative method referred to above, or when impurities are deliberately added, the resulting synthetic crystals are in these instances susceptible to darkening.

We wish to thank Mr. J. W. Ryde for helpful discussions in the course of this work. We are also indebted to Drs. Nora and W. A. Wooster for providing the synthetic crystals containing the added impurities.

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[1] Frondel, C., *Amer. Min.*, **30**, 432 (1945).
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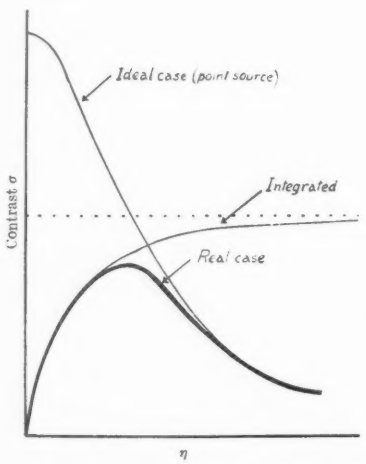
X-Ray Extinction in Type II Diamonds and Topaz

In the course of experiments on divergent-beam X-ray photography, we applied extinction theory to find how the contrast σ of deficiency lines against the background depends on η, the standard deviation of mosaic-block disorientation in the crystal. We obtained a curve (reproduced herewith) with a maximum for a value of η comparable with the angular subtense of the X-ray source at the film. For smaller values of η, σ depends chiefly on the integrated intensity of reflexion from the lattice planes concerned rather than on the ideal line profile; in consequence, as η decreases, the contrast must eventually suffer secondary extinction in the same way as single-crystal spots on rotation photographs. Instead of reaching the ideal maximum of $\frac{1}{2}$ ('Laue' case) or 1 ('Bragg' case), the curve near the origin, provided η is not too near the diffraction width, is given by the expressions:

$$\text{Laue case} \quad \sigma = \text{const.} \times \eta \sqrt{2 \ln \sqrt{\frac{2}{\pi}} \frac{Q' t'}{\eta}} \left(1 + \frac{0{\cdot}577 \ldots}{2 \ln \sqrt{\frac{2}{\pi}} \frac{Q' t'}{\eta}} + \ldots\right) \quad (1)$$

$$\text{Bragg case} \quad \sigma = \text{const.} \times \eta \sqrt{2 \ln \frac{Q' t'}{\sqrt{2\pi}\,\eta}} \left(1 + \frac{0{\cdot}577 \ldots}{2 \ln \frac{Q' t'}{\sqrt{2\pi}\,\eta}} + \ldots\right) \quad (2)$$

where Q' is volume reflecting power and t' is effective crystal thickness.



Full details together with some experimental results on organic crystals will be published elsewhere, but in the meanwhile two consequences of our investigations may be of interest.

Some earlier measurements by Lonsdale[1] for type II diamonds can be harmonized with theory by using only the single value of η (0·6 min. of arc) measured for one set of planes, without any *ad hoc* assumptions about the internal structure of the crystals. In this respect it would seem that type II diamonds are normal crystals with a rather small mosaic disorientation. It may be that type I diamonds are more perfect in having even smaller η (hence giving weaker lines) as well as perhaps having as large or larger blocks.

Similar considerations apply to integrated reflexion intensities whenever there is large secondary extinction; for example, the measurements by Bragg and West[2] on topaz. James[3] concludes that "no constant, or even approximately constant, property of the crystal slice is measured by experiments of this kind". We find, however, on the assumption that primary extinction is negligible throughout the crystal, that quantitative agreement with calculation for the (250) and (320) planes of topaz is obtained by assigning to η the value 0·07 min. of arc, which though small is still large compared with the probable diffraction-width.

It should be noted that for such small values the line-width does not vary as η but is proportionately greater, and would be of the order 0·3 min. at half maximum in this case.

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[1] *Phil. Trans.*, A, **240**, 219 (1947).
[2] *Z. Krist.*, **69**, 118 (1928).
[3] "Optical Principles of the Diffraction of X-Rays" (1948).

Fluorescence Lines in the Spectrum of Light Scattered by Calcite

USING several clear specimens of calcite, the scattered spectrum has been photographed in each case under specially favourable conditions of illumination with a Littrow quartz spectrograph and a cooled mercury arc. Besides the Raman frequencies that may be attributed to one or other of the usual exciting radiations, three new lines at 2838 A., 2883 A. and 2905 A. have been recorded in nearly all the specimens, though there appear to be slight variations in intensity from specimen to specimen. All our attempts to detect these radiations in the source itself have been unsuccessful and they cannot be interpreted as Raman shifts. The first of these is strong and the other two are relatively weak. It is not possible to attribute them to any specific element; but it seems fairly clear that they are to be regarded as a sharp-line fluorescence spectrum, occasionally met with in crystals. As a check on their being attributable to calcite, the scattered spectrum of a large clear specimen of barytes was photographed under similar conditions; but the lines in question were not found.

Similar lines were found by Rasetti[1] in calcite and in fluorite but at about 3100 A. They were attributed to gadolinium by Tomaschek[2]. We have looked for these also, but in the spectrograms obtained by us, this region, which is in the neighbourhood of the pair of strong mercury lines at 3126 A. and 3132 A., contains a number of Raman lines arising therefrom. The conditions of our experiment are therefore not favourable for recording the fluorescence lines already reported by Rasetti.

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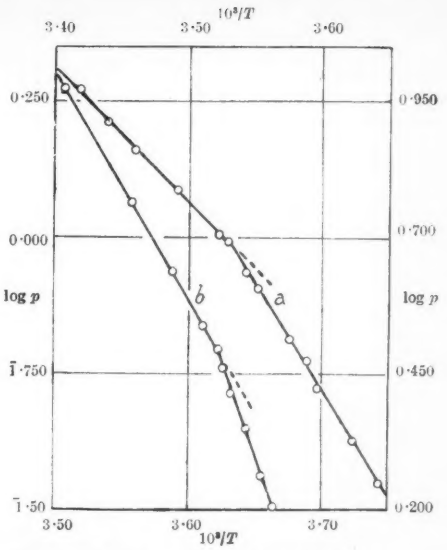
[1] *Nature*, **127**, 626 (1931).
[2] *Nature*, **128**, 495 (1931).

Melting Point of Adsorbed Liquids

Batchelor and Foster[1] found, by examination of the vapour pressure – temperature curves, that dioxan adsorbed on a ferric oxide gel of pore radius ~ 100 A. melts sharply about 6° C. below the normal melting point of the bulk liquid. During a recent investigation of the sorption of amines by silica gel, a similar effect has been observed with ethylenediamine.

A sample of silica gel was saturated with excess of ethylenediamine and the vapour pressure measured over a range of temperature just above and below the normal melting point. These pressures were identical with those determined on pure ethylenediamine in the absence of gel, and the plot of log p against $1/T$ (curve *a*) shows a sharp break at 10° C. The values quoted in the literature for the melting point lie between 8° and 11° C. The amine was then pumped off until the desorption equilibrium pressure fell to 5·41 mm. at 25° C. This represents a relative pressure of 0·403 and corresponds to a pore radius of 25 A. as calculated by application of the Kelvin equation. The equilibrium pressure was then measured over a range of temperature, giving the results shown in curve *b*. There is again an abrupt change of slope at the melting point, but for the liquid held by capillary condensation this discontinuity occurs at 3·2° C. and indicates a lowering of melting point of 6·8° C.



(*a*) Pure ethylenediamine (top and right-hand scales).
(*b*) Ethylenediamine adsorbed on silica gel (bottom and left-hand scales)

Unfortunately, the physical constants and adsorption data necessary to enable the theoretical lowering to be calculated by the method of Batchelor and Foster are not at present available; but this result confirms their original observation of the existence of a sharp melting point below the normal value for an adsorbed liquid held by capillary condensation.

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[1] *Trans. Farad. Soc.*, **40**, 301 (1944).

Correlation between Initial Young's Modulus and Differential Heat of Sorption at Zero Regain for Cellulosic Fibres

DERIVATIONS of the differential heat of sorption of dry textile fibres (ΔH_0) from measurements of heat of wetting have yielded values which are approximately equal for the cellulosic fibres (*c.* 250–300 cal./gm.). This has been taken to imply that the *type* of reaction, that is, hydroxyl bonding with water, is similar for all cellulosic fibres, and that varying hygroscopicity is dependent on the relative amount of material within the fibre which is available for moisture sorption[1–4].

A statistical analysis has been carried out on the comprehensive measurements of Rees[3] and Guthrie[4], utilizing an empirical relationship of linearity between the logarithm of heat of wetting and the moisture regain (that is, moisture expressed as a percentage of the dry weight). This analysis has shown that the differential heats of sorption of the various dry

cellulosic fibres have significant differences. The fibres which have the highest differential heats of sorption at zero regain are those with heats of wetting intermediate among those of the cellulose fibres.

If these recalculated differential heats of sorption at zero regain are compared with the initial Young's modulus of the fibres, a close correspondence is noted. The values for eleven cellulosic fibres for which data are available are shown in the accompanying table. The correlation coefficient is 0·928, which is highly significant; the residual scatter about the regression line has a standard deviation of 13 cal./gm., which is within the limits of the determination of ΔH_0.

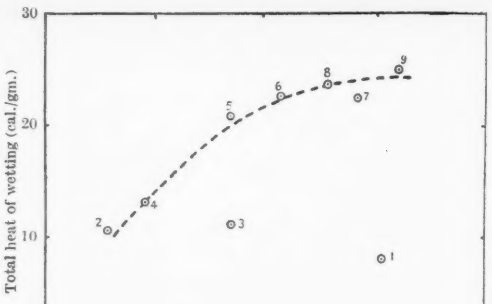
Fibre	Initial Young's modulus (see ref. 5) (gm./den.*)	Differential heat of sorption at zero regain, ΔH_0 (cal./gm.)
Seraceta (cellulose acetate)	27	264
Viscose rayon	51	219
Bengals cotton	44	232
'Tenasco' (strong viscose)	68	240
Cuprammonium rayon	68	266
'Fibro' (viscose staple)	74	244
Sea Island cotton	82	243
Mercerized cotton (under tension)	162	293
'Durafil' (very strong viscose of high orientation)	176	293
Fortisan (strong saponified acetate)	183	295
Flax	203	288

* The denier of a yarn is the weight in gm. of 9,000 metres.

An explanation of this correlation may be sought in the nature of the structure of the cellulosic fibres. The free hydrogen bonds associated with the hydroxyl groups are largely situated in the amorphous region of the fibre; those in the crystalline regions, being mutually satisfied by cross-bonding, are unavailable or inaccessible as sites for moisture sorption. The differential heat of sorption at zero regain is a measure of the freedom of the hydrogen bonds in this amorphous region, high values of ΔH_0 implying high hydrogen-bond energy. The amorphous region is also responsible for the strength of the fibre (the strength of a chain being that of its weakest link). It is the hydrogen bonds in the amorphous region which are thought to hold the fibre together when stretched[2]; thus, when viscose is wetted out, it loses strength owing to these hydrogen bonds being satisfied by water instead of exerting some mutual bond to hold the amorphous region together. The high correlation between ΔH_0 and the initial Young's modulus presents further evidence for this picture of the molecular structure and its relation to fibre strength.

For strict interpretation of the above correlation, the measurements should be made on samples drawn from the same batch of materials, and the Young's modulus determinations should be on the dry rather than conditioned (65 per cent relative humidity) material. The correlation is, however, already high in relation to the experimental accuracy and cannot be much improved by this procedure. In practice, there is a considerable drop in differential heat of sorption between the dry and conditioned state, but data to hand show that for viscose rayon this is accompanied by a corresponding drop in initial Young's modulus.

It is interesting to note that if the total heat of wetting of the above fibres is plotted against the work of rupture (as shown in the graph), some correspondence can also be seen, provided that the points for Sea Island cotton and cellulose acetate rayon are ignored. On the picture given above, we should not expect correlation between these two variables unless the hydrogen bonding was largely responsible for the entire stress-strain curve. In the case of cotton, there is a spiral morphological structure, whereas cellulose acetate has more acetyl than hydrogen bonds (2½ times for the secondary acetate); these must contribute to the strength and could account for the divergence. The deductions we can make are: (1) that for the initial strains with all cellulose fibres, it is the hydrogen bonds which give; and (2) the hydrogen bonds are largely responsible for the strength of the fibre right up to the breaking point, except for Sea Island cotton and cellulose acetate, the other structures of which dominate after the initial strain.



(1) Seraceta; (2) Bengals cotton; (3) Sea Island cotton; (4) flax (mean value); (5) 'Durafil'; (6) 'Fibro'; (7) cuprammonium; (8) 'Tenasco'; (9) viscose (mean value)

D. K. Ashpole

Textile Research Laboratory,
Courtaulds, Ltd.,
Bocking, Braintree,
Essex.
Aug. 10.

[1] Hermans, P. H., "A Contribution to the Physics of Cellulose Fibres", 37 (Elsevier, 1946).
[2] Rose, L., *J. Text. Inst.*, **40**, P1036 (1949).
[3] Rees, W. H., *J. Text. Inst.*, **39**, T351, (1948).
[4] Guthrie, J. C., *J. Text. Inst.*, **40**, T489 (1949).
[5] Mainly from Meredith, R., *J. Text. Inst.*, **36**, T107 (1945).

Preparation of Carbon-labelled Sodium Fluoroacetate on a Micro-scale

Recent studies by Peters *et al.*[1] have suggested that fluoroacetate poisoning is due to the formation *in vivo* of a fluorotricarboxylic acid which blocks the tricarboxylic acid cycle. In order to test this hypothesis, we have prepared sodium fluoroacetate labelled with carbon-14 in the methylene group.

To avoid excessively high activity, and to ensure a sufficiently large specific activity, the preparation was carried out on the millimole scale. An ampoule containing radioactive bromoacetic acid, $Br^{14}CH_2COOH$ (100–150 mgm. containing 0·1–1 millicurie), was broken in an evacuated system by a specially designed breaker. After high-vacuum transfer, the bromoacetic acid was methylated by diazomethane in ether.

The ether was distilled off at atmospheric pressure and the methyl bromoacetate transferred under high vacuum to a specially designed, stainless-steel micro-autoclave containing pure, dry potassium fluoride and a number of stainless steel balls (see ref. 2 for the macro-scale method). After sealing, the autoclave was placed in a heating block and vigorously shaken for 3½ hr. at 220°. The product was transferred *in vacuo* to a fractionation apparatus. For this purpose the high-vacuum method referred to by Sanders[3] was used, with a single fractionation. The lower-boiling fraction (n^{15}_D 1·3734–1·3700) contained 94–100 per cent of methyl fluoroacetate. The almost pure methyl fluoroacetate was titrated potentiometrically with sodium hydroxide solution in a cell attached to a pressure-equalized burette. Finally, the aqueous solution of sodium fluoroacetate was freeze-dried.

The yield of methyl bromoacetate from bromoacetic acid was 96 per cent or higher; and the yield of methyl fluoroacetate from methyl bromoacetate was 40–60 per cent. The hydrolysis by sodium hydroxide was quantitative.

In the preliminary investigation using non-radioactive material, the estimation of the fluoroacetate content of the material from the autoclave, and of that after fractionation, was most readily performed by refractive index measurement (methyl fluoroacetate n^{15}_D 1·3700; methyl bromoacetate n^{15}_D 1·4582). Fluorine estimations were also carried out. Neither of these methods was, however, readily applicable to a few milligrams of radioactive material. We have therefore measured the infra-red spectrum of the vapour of the radioactive methyl fluoroacetate produced by the above reaction, and have found it to correspond with that of artificially produced mixtures containing 95–99 per cent of methyl fluoroacetate.

A full account of the preparation and special techniques employed will be published elsewhere.

B. C. Saunders
T. S. Worthy

University Chemical Laboratory,
Cambridge.
Aug. 14.

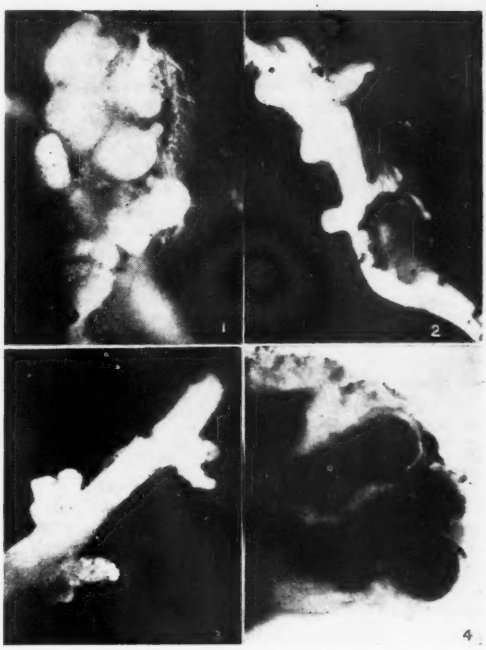
[1] Liébecq, C., and Peters, R. A., *Biochem. et Biophys. Acta*, **3**, 215 (1949). Buffa, P., Peters, R. A., and Wakelin, R. W., *Biochem. J.*, **48**, 467 (1951).
[2] McCombie, H., and Saunders, B. C., *Nature*, **158**, 382 (1946). Saunders, B. C., and Stacey, G. J., *J. Chem. Soc.*, 1773 (1948).
[3] Sanders, R. T., "Vacuum Manipulation of Volatile Compounds", 90 (1948).

Distribution of Sex in *Cryptothallus*

Material of a saprophytic liverwort, thought to be that of *Cryptothallus* sp., was received from the Brookwood locality of Surrey in December 1950. The material consisted of a number of white thalli, with ascending margins, and sectioning showed clearly the presence of a fungus in the lower cells of the thallus and in the rhizoids.

Young sporophytes were first formed in January 1951, and seven of these were observed to have matured and dehisced by the end of March. The method of dehiscence of the capsule and the *p*H of the peat in which the material was growing (namely, *p*H 3·8) were found to be in agreement with the observations on *Cryptothallus* made by Williams[1].

Since sporophytes had already been found, it was obvious that some of the plants bore female branches. Examination of the material showed the presence of young female branches on thalli bearing the remains of the old sporogonia. Observations were continued, however, in order to ascertain whether the male branches were to be found also on these plants.



Cryptothallus sp.: (1) female plant showing branches and rhizoids; (2) young female plant; (3) male plant with antheridial branches photographed by reflected light, thus showing the antheridia as white spots at tip of branches; (4) tip of male branch showing antheridia (× 36)

By the end of June, two differing types of thallus could be distinguished: the slightly larger thalli with rounded lateral branches, bearing the female organs, and the narrower thalli with lateral branches divided into two or three lobes, in which the antheridia were embedded. These male plants bear a strong resemblance to those of *Aneura pinguis*, except for the lack of chlorophyll in the cells, and it would appear that *Cryptothallus* is dioecious, since all observations point to the fact that the sex organs are segregated on separate plants.

Williams[1] has already observed the similarity in the origin and structure of the sporogonia with those of the genus *Aneura*. It is interesting, therefore, to note that the antheridia in the male inflorescence of *Cryptothallus* are arranged singly, in two rows, which again shows a similarity with this genus.

Time-lapse photography has shown that in mature male plants, mounted in water, the antherozoids escape in a slow stream from the antheridia. Each antherozoid appears to possess a spirally coiled body bearing two flagella, and closely resembles those of *Pellia* and *Aneura*.

Kathryn Bensen-Evans

Ciné Unit,
Botany Department,
University College,
Cardiff.
July 14.

[1] Williams, S., *Nature*, **163**, 769 (1949). Shaw, H. K. Airy, *Nature*, **164**, 64 (1949).

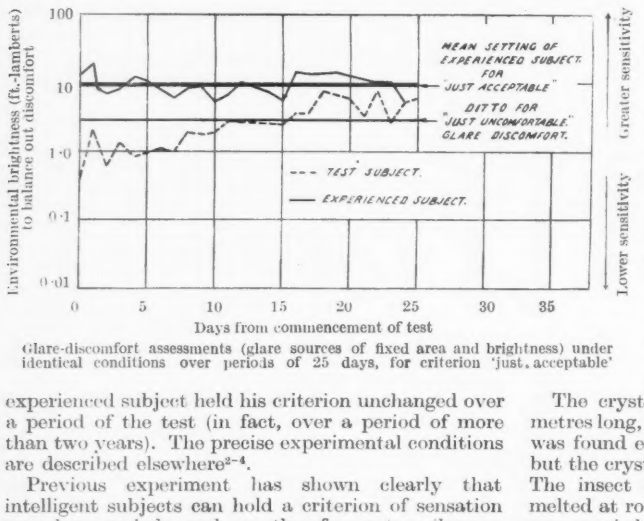
Influence of Experience on the Sensitivity to Discomfort

The sensitivity of a subject to discomfort arising from his environment may be dependent in some degree on his familiarity with, or technical knowledge of, the environment. Some evidence to this effect has accumulated from a long series of field-studies of lighting. A subject may be unconscious of glare from a bare lamp over his desk until his attention is directed to it, but thereafter may become aware of glare-discomfort in other environments as well. Other workers have recorded similar effects[1].

It was decided to test the existence of this sensitization using the apparatus of the 'control experiment' of a 'multiple criterion' study[2]. Two individuals were selected who were quite unfamiliar with lighting and glare technology, but who were intelligent in their general approach to perceptual problems. Preliminary assessments showed that they were relatively insensitive to discomfort from glare.

Each observer was then asked to make settings of the environment to give certain degrees of glare-discomfort under controlled conditions, and these assessments were repeated day after day for several weeks. Other subjects who were familiar with the experiment and its technology, and who were therefore in the 'sensitized' condition, performed the same assessments over a similar period (but the readings were not concurrent). The accompanying graph shows the observations of one such 'experienced' subject, and of one of the test subjects, over this period.

It is clear that, although at first the settings of the experienced subject and the test subject differed considerably, the test subject being less sensitive to glare than the experienced subject, as the test proceeded the test subject developed a sensitivity which approached that of the experienced subject (the other test subject showed the same trend). The



Glare-discomfort assessments (glare sources of fixed area and brightness) under identical conditions over periods of 25 days, for criterion 'just acceptable'

experienced subject held his criterion unchanged over a period of the test (in fact, over a period of more than two years). The precise experimental conditions are described elsewhere[2-4].

Previous experiment has shown clearly that intelligent subjects can hold a criterion of sensation over long periods, and can therefore act as 'human meters' of the physical factors which govern the reactions of man to his environment. They are, however, in general, although not always, more sensitive, both to changes in the environment and to the effects of the environment on their sensations, than is the 'average man', that is, the norm of the body of untrained subjects. The designer of an environment (for example, a building, a lighting or heating installation) must therefore decide whether to plan for the low sensitivity of the 'average man', or set himself the higher and more consistent standard of the experienced observer, who will, of course, be his only informed critic.

One is left with a question. In what way are individuals affected, in health or efficiency, by physical conditions which cause them no conscious discomfort, but which produce sharp reactions in the experienced subject? Will these conditions have an influence after a day's work, or a year's work? Will children, working under the heating and lighting conditions still characteristic of some of our older schools, suffer ill-effects from factors of which they are usually quite unaware?

R. G. Hopkinson

Building Research Station, Garston,
Watford, Herts. July 28.

[1] Christopher, H. N., *J. Soc. Motion Pict. Tel. Eng.*, **56**, 369 (1951).
[2] Hopkinson, R. G., *Quart. J. Exp. Psych.*, **2**, 124 (1950).
[3] Hopkinson, R. G., *Trans. Illum. Eng. Soc.* (London), **5**, 1 (1940).
[4] Petherbridge, P., and Hopkinson, R. G., *Trans. Illum. Eng. Soc.* (London), **15**, 39 (1950).

A Small Insect Enclosed in an Atmospheric Ice Crystal

Insects have been subjected to simulated upper air conditions, and the death of soft-bodied forms artificially coated with ice has been discussed[1]. However, I know of no previous record of an insect enclosed in a natural atmospheric ice crystal. A fall of ice crystals was observed in Banff National Park, Alberta, during the early evening of May 4, 1951, and one of the crystals contained a minute adult male chironomid. Weather associated with this record is described below.

Polar continental air occupied the area, and the day had been clear. At 1645 hr. (Mountain Standard Time), a small banner cloud was observed forming on the lee side of Bident Mountain. The cloud formed at the top of a sunlit slope at an altitude between 7,800 and 8,200 ft. During the period of its growth, between 1645 and 1950 M.S.T., the air temperature in the valley bottom changed from 49° F. to 42° F., and the relative humidity from 57 to 64 per cent. At 1945 M.S.T., shortly before the cloud reached its maximum development, the fall of ice crystals began, and persisted for ten minutes. The fall deposited small amounts of ice over an area much larger than that directly under the cloud.

The crystals were needle-shaped, about six millimetres long, and some were branched. The chironomid was found enclosed in one of the branched crystals: but the crystal shape was not altered by its inclusion. The insect did not recover when the crystal was melted at room temperature. Presumably, the insect was carried to the level of ice formation by the updraught on the heated slope.

W. R. Henson

Forest Insect Laboratory,
Sault Ste. Marie,
Ontario. July 30.

[1] Wellington, W. G., *Canad. Ent.*, **77**, (7), 44 (1945).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 7

SOUTH-EAST LONDON TECHNICAL COLLEGE (at Lewisham Way, Lewisham, London, S.E.4), at 7 p.m.—Mr. G. R. Leeds: "Production and Use of Diamond Powders".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Dr. Frank Hartley: "The Nomenclature of Drugs".

Tuesday, January 8

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS and RADIO SECTIONS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. L. B. Turner: "Two Electronic Resistance or Conductance Meters"; Mr. W. F. Lovering and Mr. L. Wiltshire: "A Bridge for the Measurement of the Dielectric Constants of Gases".

INSTITUTION OF MECHANICAL ENGINEERS, AUTOMOBILE DIVISION (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. R. A. Wilson-Jones: "Stability of Single-track Vehicles".

SOCIETY OF CHEMICAL INDUSTRY, CROP PROTECTION PANEL of the AGRICULTURE GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. Healy, Dr. Johnson and Dr. Peters: "The Eelworm Problem".

ILLUMINATING ENGINEERING SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Dr. W. M. Hampton: "Control of Light by a Lighthouse Lens".

Tuesday, January 8—Wednesday, January 9

ASSOCIATION OF APPLIED BIOLOGISTS (at King's College, Newcastle-upon-Tyne).—Provincial Meeting.

Wednesday, January 9

SOCIETY FOR APPLIED BACTERIOLOGY (at the Institute of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 10 a.m.—Annual General Meeting; Scientific Papers; at 2.15 p.m. (joint meeting with the MICROBIOLOGY GROUP of the SOCIETY OF CHEMICAL INDUSTRY).—Symposium on "Disinfectants".

PHYSICAL SOCIETY, COLOUR GROUP (at the Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m.—Prof. W. D. Wright: "A Preliminary Report on some Experiments on Tritanopia". Mr. R. W. G. Hunt: "Light- and Dark-Adaptation and the Perception of Colour".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. E. Boaden and Mr. E. C. Masterson: "Some Aspects of Field Operations in Kuwait".

ROYAL STATISTICAL SOCIETY, STUDY SECTION (at the Electric Lamp Manufacturers' Association, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. P. R. Cox: "The Problem of Population Projections".*

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Dr. E. G. James and Mr. G. M. Wells: "Crystal Triodes".

Thursday, January 10

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (at Radiant House, Bold Street, Liverpool), at 2.30 p.m.—Dr. A. C. Monkhouse: "Progress in Domestic Heating Research".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. J. McLean Thompson: "A further contribution to our knowledge of Cauliflorous Plants; with special reference to the Candle-Tree of Panama (*Parmentiera cereifera* Seem)".

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 5 p.m.—Dr. Walter Pagel: "Medical History at the end of the Nineteenth Century (in commemoration of the 100th anniversary of the birth of Julius Pagel)".

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. C. G. Eastwood: "The Contribution of the Colonial Empire to World Food Supplies".

Friday, January 11

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

INSTITUTION OF MECHANICAL ENGINEERING (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. John Kelly: "Rubber Technique in Engineering".

GEOGRAPHICAL ASSOCIATION (in the Geography Room, Central High School for Boys, Whitworth Street, Manchester), at 6 p.m.—Annual General Meeting; at 7 p.m.—Mr. E. Lord: "Cotton Growing in Africa".

INSTITUTE OF ECONOMIC ENGINEERING (at Cowdray Hall, Henrietta Place, London, W.1), at 7 p.m.—Mr. C. N. Potter: "Industrial Efficiency—The Management Viewpoint".

Saturday, January 12

BRITISH PSYCHOLOGICAL SOCIETY (in the Eugenics Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Prof. Daniel Katz: "Research Trends in Social Psychology".

HORNIMAN MUSEUM (at London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. W. R. O'Dea: "Artificial Lighting Prior to 1800 and its Social Effects".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMISTS (Senior Experimental Officer or Experimental Officer grade) in the Materials and Analytical Section of a Ministry of Supply research and development establishment near London: (*a*) with experience of paints, varnishes and/or plastics, (*b*) with experience of paper, and paper products and textiles—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, W.C.1, quoting F.915/51A (January 12).

EXPERIMENTAL OFFICERS, ASSISTANT EXPERIMENTAL OFFICERS and SENIOR ASSISTANTS (Scientific), IN THE DEPARTMENTS OF PHYSIOLOGY AND BIOCHEMISTRY—The Secretary, Institute of Animal Physiology, Babraham Hall, Babraham, Cambridge (January 12).

LECTURER IN METALLURGY in the Department of Science of the College of Technology—The Director of Education, Education Office, Sheffield 1 (January 12).

SCIENTIFIC OFFICER at the Council's Unit of Soil Physics at Cambridge, for work in the field of the flow of liquids in porous materials, and on soils in particular—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (January 12).

BACTERIOLOGIST or MICROBIOLOGIST in the Dominion Laboratory, Department of Scientific and Industrial Research, Wellington—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting *Nature*, Ref. A.3/64/109 (January 14).

DIRECTOR OF THE GEOLOGICAL SURVEY DIVISION, Department of Scientific and Industrial Research, Wellington—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting *Nature*, Ref. A.3/64/110 (January 14).

DIRECTOR OF EXPERIMENTS, National Agricultural Advisory Service—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 4113/52 (January 17).

BACTERIOLOGIST to take charge, under the direction of the Professor, of the Public Health and Venereal Diseases Laboratory Service for the Bristol area—The Registrar and Secretary, The University, Bristol (January 31).

JUNIOR LECTURER IN GEOGRAPHY at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 31).

MINERALOGIST (Keeper in Geology) at the Tasmanian Museum, Hobart—The Agent-General for Tasmania, 457 Strand, London, W.C.2 (January 31).

PROFESSOR OF ELECTRICAL ENGINEERING in the University and in the College of Technology—The Registrar, College of Technology, Manchester 1 (January 31).

SENIOR LECTURER IN MATHEMATICS at Victoria University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 1).

LECTURER IN THE DEPARTMENT OF ASTRONOMY, to assist with teaching and research work and to act as Assistant Director of the University Observatory, and an ASSISTANT LECTURER IN THE DEPARTMENT OF ASTRONOMY, to undertake teaching and observing duties—The Secretary, University College, Gower Street, London, W.C.1 (February 2).

ANALYTICAL CHEMIST (with a B.Sc. or A.I.R.C. and at least two years laboratory experience) in the field of ferrous and non-ferrous metals, oils and allied substances—The Secretary, Production Engineering Research Association, Melton Mowbray, Leics.

ASSISTANT (with degree, or equivalent, in metallurgy, chemistry, physics or engineering; knowledge of a foreign language preferred) IN THE INFORMATION DEPARTMENT—The Secretary, British Non-ferrous Metals Research Association, Euston Street, London, N.W.1.

ASSISTANT LECTURER (Grade B) IN THE DEPARTMENT OF PHYSICS—The Principal, Sir John Cass College, Jewry Street, London, E.C.3.

BIOCHEMIST (with degree in biochemistry, or equivalent, a good knowledge of hospital work and, preferably, with five years experience) for Area Laboratory—The Secretary, Westwood Hospital, Beverley, Yorks.

CHEMIST (with good honours degree and interests in physical and organic chemistry) in research team engaged on fundamental studies related to the constitution of coal—The Assistant Secretary, British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey, quoting Ref. A.44.

CHEMISTS by the Ministry of Supply in London and the provinces, on inspection, production, research and development, and experimental work connected with aircraft, atomic energy, armaments, ammunition and associated equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting F.917/51A.

HOSPITAL PHYSICIST for duties in the X-Ray and Radium Departments of hospitals in the Newcastle area—The Secretary, Newcastle Regional Hospital Board, Dunira, Osborne Road, Newcastle-upon-Tyne.

MECHANICAL ENGINEER in the Public Works Department Irrigation Branch, Punjab Government, to be responsible for planning a new workshop for the manufacture and overhaul of heavy valves, gearing, winches, pumps, parts of earth-moving machinery, steam rollers and other heavy equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting A.12/PE.26.

PHYSICIST to undertake and ultimately to supervise important work on the structure and mechanical properties of fabrics—The Director of Research, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

PRINCIPAL SCIENTIFIC OFFICER, to initiate and be responsible for experimental research work, both basic and applied, into problems of high-speed flight, a SENIOR EXPERIMENTAL OFFICER, to be responsible to a Principal Scientific Officer for work on the design and later for the operation and maintenance of large engineering apparatus for aerodynamic research, an EXPERIMENTAL OFFICER, to assist a Senior Experimental Officer, Experimental Supersonics, in experimental work on problems of high-speed flight, and a SCIENTIFIC OFFICER,

Grade I, to be responsible to a Senior Scientific Officer for the development of instruments for aerodynamic research and the adaptation of existing instruments for special purposes; in the Research and Development Branch of the High-Speed Aerodynamics Laboratory at Adelaide—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1.

SCIENTIFIC OFFICER (with an honours degree in science, preferably physics or mathematics, plus a postgraduate course in meteorology or practical experience in weather forecasting) to perform general scientific duties at the Royal Observatory, Hong Kong, and independent forecasting duties at Kai Tak Airport—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27118/6/51.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scottish Marine Biological Association. Annual Report 1950–51. Pp. 37. (Millport: Marine Station, 1951.) [1010

Transactions of the Royal Society of Edinburgh. Vol. 62, Part 1, No. 4: The Geology of Slieve Gullion, Foughill and Carrickcarnan, an Actualistic Interpretation of a Tertiary Gabbro-granophyre Complex. By Dr. Doris L. Reynolds. Pp. 85–143+2 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1951.) 17*s.* 6*d.* [1010

Medical Research Council. Special Report Series No. 274: Deficiency Diseases in Japanese Prison Camps. By Dr. Dean A. Smith and Dr. Michael F. A. Woodruff. Pp. viii+209+5 plates. (London: H.M. Stationery Office, 1951.) 6*s.* 6*d.* net. [1010

The Future of the Unions. (Nationalised Industry Series, 8.) Pp. iii+32. (Claygate: Acton Society Trust, 1951.) 2*s.* [1010

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